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THE PRINCIPLES OF WEATHER FORECASTING.

Forecasting Weather. By Dr. W. N. Shaw, F.R.S. Fully illustrated with maps, charts, and diagrams. Pp. xxviii+380. (London: Constable and Company, Ltd., 1911.) Price 12*s.* 6*d.* net.

THE text-book on "Weather" published by the late Hon. Ralph Abercromby in 1885 generalised the practice in forecasting which had gradually established itself in the Meteorological Office. The recognition in that book of types of pressure distribution associated with distinctive characteristics of wind, temperature, and rain, gave definiteness to the conceptions of cyclones, anticyclones, wedges, and V-depressions, and impressed on the minds of the last generation the dominance of atmospheric pressure over all atmospheric changes. Abercromby wrote with the enthusiasm of lively faith. He believed in cyclones and anticyclones as powers which made the weather—great, simple, and straightforward entities, the ways of which were almost fully known, and only a little additional knowledge required to make the prediction of weather definite and precise.

Recent meteorological researches at home and abroad have gradually involved meteorologists in an atmosphere of doubt as to the simplicity and the certainty of the relations of weather and pressure distribution. During his eleven years' labours as director of the Meteorological Office, Dr. Shaw has done much to initiate and encourage research into the problems most vital to weather forecasting, and the keenest anticipations have been formed as to the nature of the book now before us. In one way we are disappointed; Dr. Shaw has not attacked the Victorian certainties with the vigour of an iconoclast, nor proclaimed a finished system of new beliefs. He recognises the old ideas as idols, but he speaks of them respectfully, not crushingly. He adopts a deprecating tone, indeed, as of one who knows better, and insinuates the well-founded doubts which will enable every candid meteorological mind to recognise its latent idolatry and re-clothe the cyclonic Dagon or remove him quietly out of his place. The book is adapted for a transitional state of mind, ready to abandon the early ways as soon as the larger light is clear enough to make the new path plain, and that is the state of mind of all thoughtful meteorologists; hence it is suggestive rather than didactic, and stimulating rather than systematic. The main value of the work seems to us to lie in the definite formulation of the results of the recent researches carried on under the auspices of the Meteorological Office, and still in progress, researches which bid fair to reorganise the physical basis of weather study, and to make possible a real manual of weather forecasting at some future date. The actuality of the present book is its chief attraction, the reader being brought right to the front of advancing knowledge of weather conditions, and any defects it may possess are defects of that great quality.

Dr. Shaw, as we have hinted already, does not worship the conventional cyclone and anticyclone as the creators and controllers of weather; he shares Prof. Hann's view that these isobaric forms are themselves produced as incidents in the great streams of air which carry on the larger circulation of the atmosphere, and he leads towards the recognition of substantial air-currents of diverse origin flowing in various directions, meeting, and passing in various planes at different angles, as the true causes of weather. He treats moving air in accordance with the well-known principles of physics, and endeavours to establish the dynamical or thermodynamical antecedents of the meteorological phenomena concerned in weather. The work is one of immense difficulty; few men of science would have the courage to attempt it, and we are satisfied that no one having undertaken such a task could have carried it out in a more satisfactory way or with a more effective result than Dr. Shaw has achieved. In the introduction he makes much of the difficulty of the long-abused British units retained by English-speaking meteorologists in both hemispheres, and he outlines a modification of the C.G.S. system which would, he believes, greatly simplify research and exposition. He does not recommend the metric system as used by Continental meteorologists; but a derived system which has the high moral advantage of requiring to be learnt equally by our Continental friends and by ourselves, a sort of arithmetical Esperanto. Temperature is to be expressed in centigrade degrees, but from the absolute zero, so that ice melts at 273° and water boils at 373°. Pressure is to be expressed in fractions of the "C.G.S. atmosphere of 1,000,000 dynes per square centimetre," which corresponds to the normal pressure, not at sea-level, but at an altitude of 106 metres. The decimalisation of measures of time and arc are not suggested, so that the scheme lacks the roundness of theoretical perfection. In practice, so far as this book is concerned, the new system has superseded nothing, for the maps "on which," the author too modestly says, "the book is mainly dependent," are for the most part expressed in Fahrenheit degrees, inches, and Beaufort wind forces. We confess that we do not share Dr. Shaw's enthusiasm for the new system, but it is one of those matters in which the advice of Gamaliel can well be followed, and we do not raise a voice against it.

"Forecasting Weather" is treated in eighteen chapters, of which the first five deal with synoptic charts, the relation of winds to isobars, a statement of Abercromby's view of the order of weather-changes in a cyclone, which still holds good so far as the observed phenomena are concerned, types of weather, and local weather in relation to forecasting. All this is a development of what may be termed the conventional views in which most of us were brought up; but even here the development is very considerable. The question of winds and barometric gradient is happily treated, and the inclination of the wind to the isobars acquires a new significance from the demonstration that a wind moving in a circular path may alter its direction of motion without changing its velocity under the influence of a steepened gradient.

While Abercromby's view of cyclones still explains most of the appearances, Dr. Shaw is careful to point out that the old simple conception of the cyclone as a whirl of air inwards and upwards is not the only one possible, and that similar results would be yielded if the air in any part of the system performed no considerable portion of a complete revolution.

The next three chapters, on the physical processes of weather, the life-history of surface air-currents, and the minor fluctuations of pressure, are the most important in the book, for they are the embodiment of the researches made by the author and his assistants, and they are written with the freshness and conviction only possible when the facts dealt with have been won from the unknown by the narrator himself. Were one inclined to be critical one might perhaps hint that more space than is necessary for an account of weather forecasts is taken up by the curious paradox of cooling by warming, and the quantitatively insignificant condensation by mixing of air of different humidity. Such a criticism, if made, would probably be wrong, for it is precisely such cases which give force to the demonstrations of the great thermodynamical principles still imperfectly grasped by many meteorologists, though held as "fundamentals" from their youth up by the pupils of such men as Kelvin and Tait. Dr. Shaw is at his very best when unravelling the tangled skein of air-trajectories in the path of an advancing cyclone, and it is only when he comes to these chapters that a student unfamiliar with the papers in which the various researches were published can realise to the full how tenderly the author in the new light of his personal researches, which now appear for the first time in a text-book, has dealt with the prepossessions of the holder of the revolving-wheel theory of cyclones.

The old meteorologist must purge his sight of the image of the "revolving storm" if he is to understand what is, after all, the simpler statement of the onward sweep of vast air-streams on the margins or in the heart of which the various "disturbances" occur. Dr. Shaw proves to demonstration that we must view the normal condition of air as one of motion, not of rest, and that the temperate cyclones are disturbances of pressure carried along in the stream, not independent forms moving through normally still air. He shows also, as Hellmann in particular has done in his recent work on the Oder floods, that the isobars of a cyclone are not the simple flowing curves of the weather charts, but when mapped in greater detail for smaller intervals of pressure, and from more stations of observation, they show a variety of "embroidery," as he happily puts it, and in that embroidery resides the explanation of most of the anomalies of the traditional cyclonic convention. We may perhaps be pardoned for hinting that some pertinent examples of the relation of rainfall to isobars might have been obtained if the maps of heavy rains in the pages of "British Rainfall" had been drawn upon; they are at any rate the most detailed instances of the mapping of precipitation. We are also a little sorry that the French terms, *ligne de grain* and *ruban de grain* are not translated and brought into intimate relation with the English *line-squalls*, the fine treatment of which is one of the best points of the discussion of the "embroidery," though were we to sample all the good points we might run some risk of an encounter with the law of copyright.

The remaining chapters, with one exception, deal with practical matters of forecasting as carried out in the London office. Important as they are, these do not carry the same load of scientific interest as the earlier portion, in which we see the rebuilding of meteorological theory as a house is rebuilt by the successive destruction and reconstruction of parts. The exceptional chapter is that on anticyclones, which is all new and of the utmost value. But for its name, which is apparently honoured for the sake of its godfather, the anticyclone would, we fear, be cast down from its high place, and proved to be a very ill-carved fetish. The beneficent purveyor of fine weather, the promoter of brilliant summer warmth and glorious winter cold is, in fact, shown up as an isobaric fraud. The anticyclone is now declared not to be a region of dry, descending air, not to be a focus of winter cold, not to be the country of origin of outward-moving air-currents, not even to be a distinctive meteorological entity. Quoting from his "Life History of Surface Air Currents," Dr. Shaw says:—

"Further evidence in favour of regarding anticyclones as masses of air which for some reason is not taking part in the circulation going on around it may be derived from the study of anticyclones themselves. They are not of single meteorological character. Local changes of many kinds may take place within them, and almost any kind of weather, except those which represent violent atmospheric changes, may be associated with their central regions."

A chapter on "Forecasts for Aëronauts" gives occasion for a concise account of the present state of our knowledge of the upper air. Brief reference is made to statistical methods for long period and seasonal forecasting, in which various periodical relationships are touched upon, though lightly, and the book concludes with a discussion of the practical utility of weather forecasts, written in an impartial and eminently scientific spirit. In this respect a strong point is made of the necessity of trained intelligence and some knowledge of meteorology on the part of the public in order to fit them to understand and test the forecasts as issued in the Press. Until some such educational groundwork is laid, Dr. Shaw thinks that we cannot be said to have a *system* of forecasting, for the work of the office is only half the story. As to the possibility of future improvements, he says:—

"It is quite possible that the progress of research, guided primarily by the wish to improve the daily forecast, will lead to the recognition of, or find material for, the development of laws of a more general character that will enable us to anticipate the weather for the season or the month. It is only by close practical study that such an object can be achieved."

The example set by the director will, we are sure, be followed by the band of trained disciples he has gathered round him at the Meteorological Office, and

even although the infallible forecaster may never arise, the advance of knowledge by the method of research cannot fail to repay many times over the wisely administered expenditure of the public money entrusted to the Meteorological Committee.

HUGH ROBERT MILL.

THE HISTORY OF MEDICINE.

History of Medicine. By Prof. M. Neuburger. Vol. i. Translated by E. Playfair. Pp. x+404. (London: H. Frowde and Hodder and Stoughton, 1910.) Price 25*s.* net.

THE first volume of this history of medicine by the professor of the subject in the University of Vienna deals with the period *ab initio mundi* to the end of the Middle Ages. A somewhat confused preface by Sir William Osler introduces the work, asserting on the first page that professorships on the subject have been established in English universities, and on the second page that "there is not in this country a single chair of the history of medicine." The Fitzpatrick lectureship on the history of medicine in the Royal College of Physicians of London is mentioned, but Sir William Osler fails to perceive that it was established with the obvious intention that the lecturer should always be a physician learned in medicine, as well as in the part of its history which he might select for his lectures. The courses which have been delivered during the past nine years by three members of the University of Oxford and two of the University of Cambridge have shown the usefulness of such a provision. They have been worthy examples of the same school as "The History of Physick from the time of Galen to the beginning of the Sixteenth Century," written by Dr. John Freind in 1723, a book which is at once pleasant reading, sound medicine, and good history.

The history of medicine as written by men ignorant of its practice and inexperienced in the observation of disease is rarely of the first order. Littré, whose writings are a valuable contribution to medical history, is no example to the contrary, for he had completed his medical education and had meditated deeply on all he had seen in the wards, though, in consequence of his poverty, he did not actually take a medical degree. It is the fact that the late Dr. J. F. Payne was a physician of wide attainments in his profession, as well as a scholar deeply read in medical books, which makes his writings such valuable contributions to the history of medicine. Van Swieten was the chief physician of Vienna, and his commentaries on the aphorisms of Boerhaave contain a better history of the growth of the knowledge of disease up to about 1760 than can easily be found anywhere else. If a medical faculty has not in it a physician willing to add to the history of medicine, his place can never be supplied by what this preface calls "archivists" and "backstairs men."

Prof. Neuburger's first volume begins with primitive medicine as illustrated by the trephine holes in Neolithic skulls and by the proceedings of modern savages. He then gives some account of medicine among the Sumerians, Babylonians, and Assyrians, sufficient to show that scarcely anything is known of it. The next chapter, on the medicine of the ancient Egyptians, contains some interesting fragments of information, but would have been more valuable had its statements been illustrated by descriptions of the actual specimens to be seen at Cairo and in other Egyptian collections. The writings of Eliot Smith are far more illuminating on the subject of the Egyptian knowledge of anatomy, pathology, and surgery. A chapter on the ancient Persians contains scarcely enough information to rouse curiosity.

The well-known passage in Ecclesiasticus on the physician is quoted, and cannot be quoted too often, but the medicine of the Old Testament is very imperfectly discussed. Robertson Smith's acute remarks on the golden emerods and mice in relation to an early epidemic of plague, for example, are not mentioned. The medicine of Hindustan and that of the Chinese and Japanese are treated in two longer chapters, and the reader anxious for first-hand information then passes on with relief to medicine in classic antiquity, to the Homeric healing art, to the Greek physicians, theories, and medical schools, and to two interesting chapters on Hippocrates. Prof. Neuburger venerates the Father of Medicine, and says that he is

"Admired by all, really understood by few, imitated by many, equalled by none; he was the master of medicine for all time."

When it is remembered that the Hippocratic school practised, as indeed is well described in this book, palpation and auscultation, it is scarcely correct to say that "Prognosis gives to the mental attitude of the Hippocratist its characteristic colouring, and leaves diagnosis far behind it in importance," though, of course, it is true that the Hippocratic view of prognosis required the practice of an almost hourly meditation on the course of the disease *pari passu* with observation of the symptoms. The transplantation of Greek medicine to Rome, Asclepiades the friend of Cicero, as well as several later physicians and schools, are discussed. Galen is dealt with in a long chapter, and the general character of his writings is justly presented to the reader. It is certainly true that by him "special pathology is well represented, and in the chaff of irresponsible speculation there is hidden many a grain of genuine observation and surprisingly clear insight." Medicine in the decline of antiquity is then described, with a somewhat disappointing chapter on Byzantine medicine and one on Arabic medicine, which adds little if anything to the account of the Arabian physicians published by Ferdinand Wüstenfeld in 1840. The second volume is to deal with the medicine of the Renaissance and of modern times.

The defect of the book is a desire to mention too many facts, with the result that few parts of the history are set forth at sufficient length to be clear or to be interesting. Prof. Neuburger's style is often rhetorical, but he generally fails to excite in his reader a living interest in the men of whom he tells or in the books which he describes, and there is the more

serious defect that references and authorities are imperfectly given, so that the work reads like a book meant to be used in cramming men for examinations and not like a real introduction to the subject. Dr. Ernest Playfair has performed the difficult task of translation admirably.

HIGHER DYNAMICS FOR ENGINEERS.

A Treatise on Dynamics, with Examples and Exercises. By Prof. A. Gray, F.R.S., and Dr. J. G. Gray. Pp. xvi+626. (London: Macmillan and Co., Ltd., 1911.) Price 10s. net.

THE preface to this book states that it is intended "to provide a discussion of higher dynamics suitable to students of engineering, physics, or astronomy." It is doubtful whether it would be a good book for intending students of astronomy, but it will be useful both to physicists and to students of applied mathematics as supplementing other treatises, and is an excellent book for an engineer whose mathematical equipment is sufficient to follow the reasoning.

Examples of problems which occur in engineering or are of special interest to engineers appear early, and continue right through the book; in addition to those included in the majority of treatises (including trajectories in resisting media) may be mentioned resistances of water to ships, steering of ships, brakes of trains, motion of wheeled vehicles, and dynamics of self-propelled vehicles. The conditions which contributed to the Salisbury accident of 1906 are fully dicussed, and although there is a misprint in the figure used in this discussion, and a misprint of $\tan^{-1}$ for $\sin^{-1}$, the results, both algebraic and arithmetic, are correct. The reasons why a blacksmith uses small and large hammers for different purposes (p. 399) do not appear in most treatises on dynamics!

Although elementary dynamical questions like the above are clearly and fully discussed, elliptic integrals are introduced where thought to be practically useful (as in the pendulum), and there is a clear and full discussion of three-dimensional rigid dynamical problems, mainly of a practical nature. The change in the ordinary figure (art. 9) by which the usual right-handed screw notation is made consistent with the traditional forms of Euler's and kindred three-dimensional equations will commend itself equally to teachers and students of dynamics, though the figure might with advantage have been repeated in the later chapters. The principle of this article is claimed in the preface to be comparatively new, but seems not to differ from that practically used by the standard treatise of Routh. The principle is, however, expressed clearly and made good use of in the chapter on gyrostats, which should be specially useful to engineering students as giving a clear and practical explanation of a subject generally regarded as difficult. The discussions of gyrostatic control of the rolling of ships, the monorail, the gyrostatic action of turbine-driven steamers, and other questions are very full, while examples, such as those on self-steering torpedoes and on the effect of the rotation of the earth on the aiming of artillery, give practical illustrations of the value of the higher parts of the subject. The gyrostats in Thomson and Tait § 345, x., are reproduced, and partially discussed; but the discussion is not quite full enough, and it may be remarked that the azimuthal equilibrium in case 3 is said to be made stable by rotation, which is contrary to Thomson and Tait's result, and seems to be incorrect.

Lagrange's equations, though foreshadowed early in the treatise (p. 112), are not introduced seriously until chapter x.; they might have been of assistance to students in the two preceding chapters, in which tops, gyrostats, motion about a point under no forces, and motion of hoops are discussed, but the authors certainly do very well without the aid of these equations. Chapter x., which gives the transformations of Hamilton and Appell of the general equations, will be more useful to students of physics than to engineers or engineering students; but in all the rest of the book except in chapter v., which deals with orbits, the needs of engineering take a prominent place. Chapter v., which is presumably written for the astronomer, scarcely differs sufficiently from the traditional treatment to be of much use to him, although some little-known theorems by G. W. Hill and others are included in it.

A rather easy chapter on some quite simple statical properties comes as a surprise at the end of the book, following the advanced chapters on rigid dynamics, and is scarcely in keeping with the character of what precedes. But the general arrangement and presentation of the subject is likely to be most useful to all engineering students of sufficient mathematical capacity, and to many students of physics and of applied mathematics.

There are a few misprints, in addition to those noted above, but none which could not be readily corrected. A little revision of pp. 392 and 393, and a re-wording of the second line of p. 137 might be useful in subsequent editions. The results of the examples, so far as the reviewer has verified them, seem to be correct.

APPLIED MICROBIOLOGY.

Einführung in die Mykologie der Genussmittel und in die Gärungsphysiologie. By Prof. Alex. Kossowicz. Pp. viii+211+2 plates. (Berlin: Gebrüder Borntraeger, 1911.) Price 6 marks.

THIS work, a companion volume to the author's "Mycology of Foodstuffs," deals with those adjuncts of the table the use of which, although not strictly necessary, and classed, and for the most part taxed, as luxurious, has become so firmly established that few of us are sufficiently Spartan entirely to avoid it. Fermented beverages, both alcoholic and (reputedly) non-alcoholic, vinegar, mustard (of the French variety), vanilla, cocoa, coffee, tea, and the post-prandial cigar are all submitted to processes of fermentation at one stage or other of their progress towards that culmination of perfection which delights the connoisseur. It is with the organisms concerned,

the changes produced, and the diseases to be guarded against in the subtle preparation of these different articles of daily use that the author is concerned.

The treatment of this varied assortment of subjects is somewhat condensed, no doubt from limitations of space, but the reader is supplied with a considerable amount of information about each, much of which is extremely interesting. In every case a useful outline of the method of manufacture or preparation is given, at all events as regards that stage of it in which fermentation is involved.

The treatment of the various processes dependent on alcoholic fermentation is too condensed to be entirely satisfactory, although all the essential points are touched upon. A somewhat disproportionate amount of space is devoted to the discussion of the "bios" question, which, however interesting in itself, is not of supreme technical importance. The fact, first observed by Wildiers, that yeast when inoculated in small amount into a synthetic medium fails to grow, was explained by him as due to the absence from such a medium of some specific material essential for yeast growth, and to this unknown substance he gave the name of bios. It is probable that the explanation advanced by Pringsheim, that yeast can only gradually adapt itself to the assimilation of the nitrogen of such media, is correct, although it seems also to be true that different yeasts possess very varying degrees of adaptability. In view of these facts it is remarkable that Pasteur was so successful in his classical experiments on the growth of yeast in simple media, and it has been suggested that this success was due to the presence of mycoderma in his yeast, the presence of this organism having been found to enable yeast to grow freely in media such as he employed.

The function of fermentation processes in the preparation of alcoholic beverages and vinegar is, of course, the fundamental one of producing the essential constituent—the alcohol or acetic acid—by biochemical change from the materials present in the liquid employed. When we turn to the other substances on our list, however, this is found to be by no means the case. Coffee consists of seeds or beans which occur firmly embedded in an integument, the whole forming the fruit of the plant. The chief function of the fermentation in this case seems to be the loosening of this integument, so that the beans can readily be separated and dried, and this is effected by the decomposition of a viscid layer immediately surrounding the seeds, an alcoholic fermentation of this material occurring first, and being followed by a stage in which acetic acid is produced, a considerable rise of temperature accompanying the change.

Black tea and tobacco, on the other hand, are submitted to processes of fermentation the object of which is the attainment of the flavour and aroma upon which their value depends. In both cases opinions are divided as to the exact nature of the process. On one hand it is maintained that micro-organisms are essential agents and it has even been proposed to impart the aroma of the finer qualities of tobacco to inferior material by inoculation with the appropriate organisms. On the other hand it is contended that the change is enzymic, due to the decomposition of glucosides and to oxidation processes, although it is admitted that organisms are present and may have some secondary and minor effect on the result. In the case of cocoa, too, some doubt exists as to the relative share of plant enzymes and extraneous organisms in the fermentation to which the beans are submitted, and which results in a dry bean of good flavour and colour.

The preparation of mustard has been specially investigated by the author. A mixture of ground white and black mustard seeds (respectively containing sinalbin and sinigrin) is treated with 2·5 per cent. acetic acid, along with salt and a mixture of spices. The chief change which occurs is the decomposition of the glucosides with the liberation of the mustard oils. The mass is then left for a few days, ground and bottled. Since the glucosides of mustard are remarkably resistant to the attack of most bacteria and the mustard oils are strong inhibitants of bacterial growth, although not particularly powerful antiseptics, it might be thought that mustard would be free from liability to bacterial "disease." This is, however, not the case, and the author has isolated two species of sporing bacteria (*B. sinapivorax* and *B. sinapivagus*) which are capable of decomposing the mustard glucosides, in one case with evolution of gas, and occasionally cause serious loss to the manufacturer. The book, which, as will be seen, deals with an extremely interesting subject, is provided with a good index and bibliography, and is adequately illustrated.

A. HARDEN.

SOME RECENT WORKS ON MATHEMATICS.

(1) *Lehrbuch der Mathematik für Studierende der Naturwissenschaften und der Technik: Einführung in die Differential- und Integralrechnung und in die analytische Geometrie.* By Prof. G. Scheffers. Zweite Auflage. Pp. viii+732. (Leipzig: Veit and Co., 1911.) Price 18 marks.

(2) *Die Integralgleichungen und ihre Anwendungen in der mathematischen Physik.* By Adolf Kneser. Pp. viii+243. (Braunschweig: Fr. Vieweg und Sohn, 1911.) Price 6 marks.

(3) *Untersuchungen über Oszillationstheoreme.* By Dr. phil. Otto Haupt. Pp. 50. (Leipzig and Berlin: B. G. Teubner, 1911.) Price 2 marks.

(4) *Die partiellen Differentialgleichungen der mathematischen Physik, nach Riemann's Vorlesungen in fünfter Auflage bearbeitet.* By Prof. Heinrich Weber. Erster Band. Pp. xviii+528. Zweiter Band. Pp. xiv+575. (Braunschweig: F. Vieweg und Sohn, 1910, 1912.) Price 12 and 15 marks.

(5) *The Dynamical Theory of Sound.* By Prof. Horace Lamb, F.R.S. Pp. viii+303. (London: Edward Arnold, 1910.) Price 12*s.* 6*d.* net.

(6) *A Logical Notation for Mathematics.* By Robert T. A. Innes. Pp. 3. (Cape Town: S.A. Association for the Advancement of Science, 1911.)

(7) *Vorlesungen über Variationsrechnung.* By Prof. Oskar Bolza. In drei Lieferungen. Pp. iv+iv+x+706+10. (Leipzig and Berlin: B. G. Teubner 1908–9.) Price 19 marks.

(8) *Die Prinzipien der Mechanik für eine oder mehrere von den räumlichen Koordinaten und der Zeit abhängige Variabeln, II.* By Leo Konigsberger. Pp. 24. (Heidelberg: Carl Winter, 1911.)

(9) *Theoretische Mechanik.* By Prof. R. Marcolongo. Autorisierte deutsche Bearbeitung. By Prof. H. E. Timerding. Erster Band, Kinematik und Statik. Pp. viii+346. (Leipzig and Berlin: B. G. Teubner, 1911.) Price 10 marks.

(10) *Sur la notion de Courbure, et sur quelques points de Geométrie infinitésimale non euclidienne.* By C. Cailler (Mémoires de la Société physique et d'Histoire naturelle de Genève xxxvii, 2.) Pp. 62. (Genève: Georg et Cie., 1911.) Price 5 francs.

(11) *Proceedings of the London Mathematical Society.* Second series. Vol. ix. Pp. xvi+489. (London: Francis Hodgson, 1911.)

(12) *Bulletin of the Calcutta Mathematical Society.* Vol. i., No. 3 (October, 1909). Pp. 70. (Calcutta: Mathematical Society, Senate House, Calcutta, 1911.) Price 10 rupees per year.

(13) *Revista de la Sociedad matemática española,* 1–5 (Mayo-Diciembre, 1911). Pp. 40–76. (Madrid: Dr. José Nungot, Universidad Central, 1911.)

ONE of the most important facts which modern mathematicians now realise is that the principles of the differential and integral calculus can be taught to beginners by simple methods involving only a knowledge of the rudiments of algebra, and later on of trigonometry. There are not many teachers still in the dark on these points, though a remarkable exception occurred recently when an anonymous author wrote a book intended to show that certain fools called mathematicians had made the calculus unnecessarily hard, and proved his point, not in the way he probably contemplated, but by establishing the fundamental formulæ with a wasteful luxuriance of infinite series and disregard of small quantities which would have formed a more fitting subject for a book entitled "Calculus Made Difficult." The change has been marked in England by the appearance of a flood of school calculuses, reminding one of the former flood of school geometries.

(1) In these circumstances English teachers will derive considerable interest from studying the elementary but rigorous treatment of the subject in Dr. Scheffer's "Lehrbuch der Mathematik." The first chapter introduces the arc or radian measure of angles, and deals with functions in general. It opens with a careful comparison of the uses of graphic and analytical methods of solution, which should be a lesson to those teachers who try to hide up the shortcomings of constructive geometry by making their pupils use hard pencils. The notion of a differential coefficient is introduced in the first instance by consideration of linear and quadratic functions. Then follow the formulæ for algebraic functions deduced from the sum and product rules, and the rule for functions of functions, which is here enunciated as the chain rule. Differentiation of a power is deduced from the product rule by mathematical induction, as it should be, the use of the binomial theorem being avoided. The elements of the integral calculus are treated next, and it is only after this that the notion of a natural logarithm is shown to follow directly from the calculus, exponential functions being taken in the succeeding chapter, and trigonometric functions coming next. The chapter dealing with these contains a synopsis of trigonometry. For English readers the hyperbolic notation ("ſin, coſ," printed in German type) is perhaps inconvenient. Then follow successive differentiation, maxima and minima, curvature and evolutes, particle dynamics, Lagrange's and Taylor's formulæ, miscellaneous methods of integration, Fourier's series, and partial differentiation. At the end is a useful collection of tables and integration formulæ. A large number of applications are given in the form of examples, some completely worked out, others left to the reader.

It need scarcely be pointed out that no two writers would agree as to what should be included in a book of this kind, and what should be omitted. On the whole, this book tends on the side of thoroughness, rigorous development, and careful discussion of points of detail, notably in dealing with such matters as continuity. Possibly there may be few students of physics in this country who do not have to skip over and take for granted some of the arguments. But in such matters as order of treatment and rendering the subject independent of an extensive previous knowledge of algebra and geometry, the book pretty nearly reaches the goal towards which modern teachers have been striving.

The influence of pure mathematics on the progress of mathematical physics is well shown by the next group of books under review. The partial differential equations of physical problems have received so much attention at the hands of both mathematicians and physicists that we had begun to think that their study had reached a stage of finality in which nothing further of importance remained to be done. But during the last ten years harmonic analysis has been completely revolutionised by the development of the theory of integral equations, which places a new and powerful weapon in the hands of the applied mathematician. This modern theory traces its origin back to Fredholm's paper of 1900 on Dirichlet's problem, and the most important subsequent works are those due to Stekloff, Hilbert, and Schmidt; in particular Hilbert's "Foundations of a General Theory of Linear Integral Equations."

(2) Dr. Kneser's contribution to the new subject is exactly described by the following notice of the publishers:—

"The present work develops the theory of integral equations not from the starting point of analytical generalities but from the theory of heat-conduction, of free and forced oscillations and of the potential. The author thus hopes to meet the requirements of those mathematicians and physicists who wish to apply the new analytical method to concrete questions."

Now, in endeavouring to get the whole hang of the problem, so to speak, condensed in a nutshell, or, in other words, to find out what the investigations are driving at, and to put the matter in a form in which it could be explained to a pupil in ten minutes, the

present reviewer encountered a slight difficulty at the outset.

Dr. Kneser starts with the problem of linear conduction of heat, but the reduction to an integral equation depends essentially on the introduction of Green's function. Now we have always regarded Green's function as connected with the problem of the potential; and, further, most elementary English books on analytical statics get no further than explaining Green's *theorem*, and possibly stating Green's *problem*, but not defining Green's *function*. The necessary light was thrown on the subject by referring to p. 241 of Weber's treatise reviewed below, which not only gives, for the problem of the potential, the definition of Green's function, but shows, further, how this leads at once to an *integral equation* for the potential of a given distribution subject to given boundary conditions. In the case of the potential due to *fixed* charges, this integral equation, of course, degenerates into an ordinary integration formula.

In heat conduction and allied problems Green's function between two points, P and Q, might be defined as the temperature or potential function at one point due to a unit source, at the other subject to the given boundary conditions. This function is the nucleus or kernel (Kern) of the integral equation, *i.e.* the factor which multiplies the unknown variable under the sign of integration.

After heat conduction in one dimension, Dr. Kneser applies the method to the problem of small oscillations, Sturm-Liouville's functions, and problems in two or three dimensions, the remaining sections being devoted to the existence theorem, Dirichlet's problem, and Fredholm's series.

(3) A closely allied line of investigation is developed in Dr. Haupt's pamphlet on "Oscillation-theorems," which is divided into two parts, the first dealing with the general linear homogeneous differential equation of the second order containing an arbitrary parameter in its undifferentiated coefficient, while the second deals with the special differential equation of the fourth order, in which the second differential coefficient of a multiple of the second differential coefficient of the dependent variable is proportional to a multiple of the variable itself, the multipliers being functions of the independent variable. It is largely a development of Hilbert's work on integral equations, and deals in particular largely with the conditions under which such differential equations may lead to a "Green's system," and the corresponding forms of the boundary conditions.

(4) That integral equations are destined to play an important part in the formal treatment of mathematical physics is now evident. It does not appear, however, probable that they will at present supersede the use of harmonic analysis for purposes of calculation. In bringing out a fifth edition of his "Partial Differential Equations based on Riemann's Lectures," Prof. Weber plainly states at the outset that he has not been able to rewrite the book on the lines of recent researches, partly owing to want of time and energy, and also partly on the ground that the subject is now in a transient stage, in which further developments may be expected every day, so that if an attempt were made to start afresh, the whole book would soon be out of date. In addition to the theory of integral equations, a second line of recent development has grown up in the study of the principle of relativity.

In these circumstances Prof. Weber has adopted the most desirable course, namely, to introduce references to this recent work into the text at suitable places, and his book still constitutes as good an introduction to the study of mathematical physics as could well be written. Although the book has more and more become the work of Weber himself, he still desires to pepetuate the name of Riemann as having sown the seed from which this large tree has grown up.

The second volume has only just appeared. It deals with the theory of certain differential equations, heat-conduction, elasticity, theory of vibrations of strings, and membranes, electric oscillations, and hydrodynamics.

We have referred to the unsuitability, for English readers, of the German hyperbolic notation, but a greater difficulty is introduced into these German treatises by the use of a single integral sign to denote surface and volume integrals. It certainly adds considerably to clearness of exposition to use double and triple integral signs in these cases. Of course, this method is illogical as practised in this country, where a triple sign of integration is often followed by a single differential. The correct plan in such cases is to denote surface and volume differentials by d^2S and d^3V instead of dS and dV, and it is much to be wished that this were always done.

(5) The somewhat brief discussion of vibrations in the last-named treatise is a reminder that, unfortunately, a review of Prof. Horace Lamb's "Dynamical Theory of Sound" has been unavoidably delayed for an inordinate time. The subject is one which lends itself to treatment in three ways; by the publication of memoirs on specialised researches, by the production of a treatise even larger and more exhaustive than Lord Rayleigh's three volumes, and by the compilation of an introductory treatise in which the most important fundamental principles are dealt with concisely, over-elaboration being avoided. Prof. Lamb has chosen the last alternative, and has thus produced a book which should be of great use to students of applied mathematics, physics, and acoustics.

This aim at brevity necessitates the omission of details of long analytical investigations, the results of which are stated without proof; for example, under Fourier's series no attempt is made to reproduce the existing literature relating to its convergency, and the theory of vibrating systems in general is discussed briefly without reference to more than a statement of results in connection with transformation to normal coordinates. The various chapters following the introduction deal with general theories of vibration, strings, Fourier's theorem, bars, membranes and plates, plane and spherical sound waves, generation and diffraction of waves, pipes and resonators, and physiological acoustics, the last-named chapter being a summary of a branch of acoustics falling outside

the general scope of the book. It is probable that the average student would do better to follow a course of this kind, and then single out some subject for specialised study rather than to spend time on reproducing analytical investigations about the truth of which no doubt exists.

We notice that both Weber and Lamb assume that in a membrane the stress is the same in all directions—in other words, isotropic. Is this necessary? Analytically speaking, if the stress is homogeneous but not isotropic the membrane can be projected orthogonally into one in isotropic stress; on the other hand, it is fairly certain that in an actual membrane, such as that of a concert drum, it is very difficult to adjust the tension round the boundary so as to make the stresses either homogeneous or isotropic. A material membrane probably differs in its physical properties from the ideal membrane (Lamb, p. 189) to the same extent that the substance of which it is composed differs from a fluid. If this view is not correct further discussion is needed.

(6) Reference to notation under (4) leads us to Mr. Robert Innes's short Cape Town note, in which he recommends the use of small letters, Roman, italic, Clarendon, and Greek for symbols of quantity, and capital letters for symbols of operations, such as S for sine, D for differential coefficient. He does not tell us what he would do with separate differentials. In view of the fact that after these many years we still have to write cosec x for what is logically $\sin^{-1}x$, and that a Frenchman or German cannot *say* such a number as 394 in the form in which it is written, it is not much use suggesting reforms, except in notation the use of which is very limited.

(7) In a review like the present, it would be impossible to enter into a detailed criticism of the German edition of Dr. Oskar Bolza's "Lectures on the Calculus of Variations." While based on his American work bearing the same title, these three volumes aim at a more comprehensive treatment of the subject; at the same time, the author does not claim to have exhausted the theory even in the seven hundred pages which he has devoted to it. What he has rather aimed at has been to give a fairly elementary outline of the main principles of the calculus of variations, together with a more detailed treatment of its modern developments. The author's claim to have clearly expounded the fundamental definitions and methods, with the assistance of suitable geometrical and other illustrations, is fully justified by a survey of the contents. At present there are only a few people in England who study calculus of variations, and it is to be hoped that the subject will become more popular in the future in view of its important applications to physical problems. "Differentiation of an integral," which leads directly to "variation of an integral," is really one of the easiest things in the calculus to treat in an elementary way, and there can be no excuse for keeping this study, so to speak, under lock and key, only to be shown to students on rare occasions. The student of physics who goes no further than the first chapter of this book will be able to obtain a proof of Lagrange's equations of motion, together with a knowledge of the principle of least action, which will do him far more good than letting x equal a function of t, θ, and ϕ, and writing out by heart a proof of these equations involving some juggling with differential coefficients the physical interpretation of which is not obvious.

On the other hand, the need for an exposition of modern developments of the subject is shown by the many recent papers that have appeared. For example, a paper in German on the invariant form of the second variation of a double integral is contributed to the Proceedings of the Tokyo Mathematical and Physical Society for September, 1911, by M. Fujiwara.

(8) Closely allied, as leading to a generalised form of the principle of least action, are Prof. Konigsberger's papers on the principles of mechanics for one or more dependent variables, of which the second part has reached us.

(9) An examination of the contents of "Theoretische Mechanik" leads to the impression that Dr. Timerding showed want of judgment in undertaking the translation into German of a book like that of Marcolongo's. It is known that Profs. Marcolongo and Burali Forti have been engaged in drawing up a report on vector notations, as to the value of which considerable differences of opinion exist. We should not, however, take any exception to the book on this ground; but when we find in the second chapter difficult theorems in potential analysis, such as Stokes's and Green's theorems, and Poinsot's construction for the motion of a rigid body under no forces in chapter vii., while it is not until much later on that the author deals with such elementary notions as the parallelogram of forces, the principle of the lever, equilibrium on an inclined plane, and the principle of Archimedes, the book may fairly be regarded as affording a lesson as to how mechanics should *not* be taught. It forms a striking contrast to the clear and practical exposition of advanced dynamics contained in Webster's book, published by the same firm. It is becoming more and more recognised every day that the study of mechanics should be approached by beginners from the experimental side, and for this purpose elementary statics and hydrostatics form the best starting point. With such a preparation, a pupil may be able in time to grasp the nature and use of vector analysis, but to start him, as this book does, at the wrong end would be fatal.

(10) In his paper on curvature, Prof. Cailler has set before himself the task of formulating a theory of curvature of a sufficiently comprehensive character to cover the two cases of Riemann's and Lobatschewski's non-Euclidean geometries. To do this he has found it necessary to start with an algebraic definition of curvature based on considerations of kinematic geometry, and while admitting that some of the notions in his paper are of a somewhat abstract character, Prof. Cailler claims that the nature of the problem and the differences existing between the various kinds of space to which it refers render such a treatment necessary if it is to possess the required degree of generality.

(11) The volume of the London Proceedings before us continues to afford evidence of the good work that

is being done by those English mathematicians who, by denying themselves the luxuries of life, or otherwise, are able to give time and thought to original work. Applied mathematics is only represented by Dr. Nicholson's paper on scattering of light by a conducting sphere, and Mr. F. B. Pidduck's note on stability of rotating shafts. The most substantial contribution to pure mathematics is Dr. W. H. Young's series of seven papers dealing with various points regarding the foundations of the differential and integral calculus. At a time when the teaching of this subject to elementary classes is receiving so much attention, it is most fortunate that our country has been able to produce a mathematician like Dr. Young, who is underpinning this structure with a foundation of rigorous reasoning. For example, one paper is called "A Note on the Property of Being a Differential Coefficient," while in another paper on "A New Method in the Theory of Integration," the author proves a number of interesting results, such as that "an upper-upper-lower-upper (lower-lower-upper-lower) semi-continuous function is an upper-lower-upper (lower-upper-lower) semi-continuous function."

Lieut.-Colonel Allan Cunningham writes "An 8-vic, 16-ic, . . . , Residuacity," while it may be desirable to explain that Mr. G. T. Bennett's note on "The Double Six" refers to certain lines associated with quadric and cubic surfaces. We have one fault to find with the binding; the top edges of the pages are cut, but the outside edges are left rough, and are very uneven, consequently the pages soon get to look untidy; and, furthermore, the book always opens at certain pages and never can be opened at others.

One cannot, however, help regretting that there are probably many hundreds of persons in this country engaged in teaching mathematics who are ignorant of the very existence of these Proceedings. It would be a great advantage in this respect if the London Mathematical Society and the Mathematical Association could be amalgamated so that the educational and "original work" aspects of mathematics could be brought into closer touch with each other, as appears to be done in the American Mathematical Society. A very similar fusion of theoretical and practical interests has just been effected in the Aëronautical Society.

(12) One thing further is needed, namely, the publication of a summary of current mathematical literature, with abstracts of the principal papers. This is furnished by the Bulletin of the Calcutta Mathematical Society, which, in addition to original papers by Cullis and Mukhopadhyaya, contains a summary of the principal mathematical journals, reviews, lists of papers under "Societies and Academies," "Notes and News," "New Publications," and an obituary notice of Prof. Simon Newcomb.

Assuming that the Calcutta society is sufficiently powerful efficiently to continue the publication of these notes and abstracts, it is surely somewhat humiliating to think that the mathematicians of a Western civilisation should have to send to Calcutta for a list of the papers which they themselves have written. But as it is stated that the Bulletin will appear four times a year, while the number before us for October, 1909, bears the date of printing 1911, and was only received for review on October 14 last, we have some fears lest the task which these Calcutta mathematicians have undertaken may have proved too heavy for them. If so, we hope that European mathematicians will take steps to ensure the continuation of a chronicle which is unique of its kind.

(13) Although it has been mentioned in the "Notes" column of a previous issue of NATURE, the Spanish society's "Revista" may with advantage be referred to in this connection as showing that Spain has obtained an amalgamation between theory and practice of the kind which we in England have hitherto failed to attain. On the theoretical side we have papers on such questions as summation of series, polygonal numbers, generalisation of the nine-point circle, meridian arcs, and equilibrium of a moving chain (the figures, however, show the rubber belt of the barber's hair-brushing machine upside down, and the wheel moving in the opposite sense to the belt). On the more popular side we have biographies of Fermat, Nunez, Benaflah, and Siliceo, a history of Spanish mathematics, reviews, notes and news, and notes and queries columns. In addition, the society is drawing up a vocabulary of Spanish mathematical terms. We cannot better close this review than by quoting an extract from the article, "Sursum corda," by Captain Durán Loriga, on the functions of the newly founded society, in which he says, "The first which imposes itself is to create a *mathematical atmosphere (ambiente matemático)*, in particular to convince the whole world that without that great science it would be impossible to approach the study of natural and physical sciences, which daily tend more and more to assume a mathematical form."

This quotation is not the only or even the most powerful argument in Captain Loriga's article, which further refers to the epoch-making discoveries of Abel (who lived and died in great poverty), Kowalewski, and others, and their influence on the progress of applied science. But his notion of an "ambiente matemático" should be kept prominently in mind by all mathematicians who are able and willing to take part in the campaign which in our country requires to be waged against "England's neglect of mathematics." This campaign can only be successful if everyone who is interested in the progress of pure science lends a helping hand. If they will not, then we must let the coming generation make the best it can of the knowledge which it has inherited from its forerunners, and leave posterity to fend for itself.

G. H. BRYAN.

OUR BOOK SHELF.

The Principle of Individuality and Value. The Gifford Lectures for 1911, delivered in Edinburgh University, by Dr. B. Bosanquet. Pp. xxxvii+409. (London: Macmillan and Co., Ltd., 1912.) Price 10s. net.

THIS may be described as a reply to the critics of Absolutism, mainly, of course, the late Prof. James. Dr. Bosanquet is always as readable as the difficulty of his subject permits, and his rejoinders are always moderate and courteous. The reader feels that the

author is really seeking the truth, and not a mere gladiatorial victory or scoring of points.

The section most interesting to scientific workers is that in which the author discusses vitalism and the relation of mind to body. Quoting Bergson, Ward, and Taylor, he expresses disapprobation of the theory of "guidance." On this theory, mind and its world, choice and action, become "utterly discontinuous." The choosing unit or element is not a system of the contents dealt with by choice. The "plan" is brought to the material; it is not in it or elicited from it. The view in question is a survival in principle of the notion of matter *plus* miracle—the attitude of common external teleology (p. 205 and foll.). Moreover, there is the difficulty about energy. The guidance theory tries to shade this down by analogies such as the trigger, the ball or water-drop on a high divide, or the spark which explodes the gas in a gas-engine. In these cases a small variation in energy-expenditure may cause huge differences in result. But some expenditure there must be. On the analogy, the mind must furnish energy without participation of the body. "Views of this type only escape manifest conflict with common sense by restricting the amount of energy so furnished to an amount below the possibility of measurement" (xxvi.).

Many readers who have studied with interest and admiration the writings of Driesch, Bergson, and Lodge on this point will feel that Dr. Bosanquet's objection is a formidable one; as is also his criticism of Prof. Bergson's startling contention that contemplative and motor memory are radically different, the former being independent of brain. It is true that these are matters of science, and philosophers must tread warily in the foreign territory; but their outlook is wider—though with less perception of detail near at hand—and their criticism is to be desired and welcomed.

A Nature Calendar. By Gilbert White. Edited and with an introduction by Wilfred Mark Webb. Pp. xii+62+xiii-xx. (London: The Selborne Society, 1911.) Price 25*s.* net.

THIS beautiful facsimile, published by the Selborne Society, reproduces a record for the year 1766 of botanical observations made chiefly at Selborne, with an occasional note on birds or insects. This record, of which the MS. is in the possession of Mr. Webb, has never been before published, and is not to be confused with the so-called "Naturalist's Calendar," often printed at the end of the "Natural History of Selborne." The printing, paper, and binding of this large volume are all admirable, and the brief introduction is adequate; it is a superb volume to lie on a drawing-room table and be admired by the chance visitor, who will, it may be hoped, at least be struck by the strong, firm, and legible handwriting of the famous naturalist. White himself would be amazed at the magnificent dress in which his humble notes were destined eventually to appear; no man could know better than he that in no sense whatever could they form even the material for a book. Yet Mr. Webb claims that "now after an interval of a hundred and twenty-three years a second *book* makes its appearance in the shape of the present volume." White published but one book, and that an incomparable one. Mr. Webb publishes for him a second one, under the auspices of the Selborne Society. Making all allowance for enthusiasm, and for the carefulness of the editing (of which the excellent index is perhaps the best part), those who know how real books can only be built up on a foundation of lengthy studies, and how unwilling an author is to have such studies exposed to the gaze of the curious, will feel some regret that this rather meagre diary should have been thus magnificently produced. W. W. F.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Contour Diagrams of Human Crania.

HAS not Prof. D'Arcy Thompson got over the "lack of fixity and precision" in the individual judgment involved in superposing two cranial contours by selecting, quite arbitrarily, the vertical axis of the transverse section as the length to be equalised in all such sections? May I suggest that he should try equalising his auricular distances, and taking his percentage differences on the *vertical* ordinates? I fancy he will then find that the differences in form of two skulls will not even be emphasised at the same places as on his arbitrary scheme.

Again, in the case of the sagittal section, there are at least half-a-dozen fundamental lines any one of which might find justification in individual judgment as a standard for equalising size. A mathematician would probably object to equalising any *lines* at all, but would magnify up all his sections to be of equal *area*. He would then be certain that the total area intercepted between his superposed contours—however placed—was zero. This would certainly mean that on any reasonable superposition the contours would be very close together. In such case for the transverse section, we should all probably superpose the median lines, but, again, whether we should put the vertex on the vertex, or the auricular line on the auricular line, or superpose neither, would be matter for discussion, if not for individual judgment. The width of individual judgment allowed in the case of the sagittal section, having regard to such standard lines as either the "horizontal plane" provides or as join nasion, bregma, lambda, inion, opisthion, and basion, is so great that Prof. D'Arcy Thompson's method would require a craniological concordat before it could be put into practical form, even supposing we could agree on what should in this case be the "area" of the section.

Still another group of investigators might consider it desirable to equalise, before superposition, not any arbitrary lines or much more definite areas, but the *volumes* of the two type crania as determined, say, by average capacities or by the product, perhaps, of three arbitrary diameters. Be this as it may, either an equalisation of areas or of volumes seems to me a more reasonable preliminary to comparison of form than any equalisation of an arbitrary line. Yet such equalisations will also leave a "lack of fixity and precision" in our results. We wish to test how far our contours are similar and similarly placed curves; we ought to bring something approaching a "centre of similitude" into superposition in both contours; the orientation in the case of the transverse and horizontal sections will present no difficulty—in the case of the sagittal it is much more questionable. The mathematician would possibly select as his centres for testing similitude the centroids of either the contours or of their areas—if he were equalising areas, probably the latter.

I would therefore suggest as a method to be compared with Prof. D'Arcy Thompson's results, say, in the first place, for the transverse contours:—(1) the equalisation of areas; (2) the superposition of centroids of areas; (3) the orientation by parallelism of median lines; (4) the comparison along rays through this centroid. Thus the contours themselves would be directly compared, and not auxiliary curves. Lastly, if the superposed contours be divided into equal *angular* elements σ, and ν be the mid-distance of any element of the first contour from the common centroid, ν' the distance along the same ray to the compared contour, then

$$m = \mathrm{S}\left\{\left(\frac{\nu' - \nu}{\nu' + \nu}\right)^2 \sigma\right\} \Big/ \mathrm{S}'(\sigma),$$

where S denotes a summation for every element, would be a fit measure of the degree of resemblance.

Possibly some mathematician may be willing to undertake the general theorem: Given two oval curves, the shape of which must not be changed (but size is change-

able), find a good measure of their degree of similitude with a given orientation.

The problem is one over which the late Sir Francis Galton was at times much exercised when discussing the resemblance of portraits of the silhouette type. It was further considered very fully when the proposal to prepare average or type cranial contours was originally discussed in the Biometric Laboratory some five or six years ago. Prof. D'Arcy Thompson's scheme is suggestive, but it is very far from unique. I feel doubtful whether any scheme for all these contours could possibly be other than conventional, but I suggest that, even for a good conventional scheme to be reached, we must have further knowledge of the mathematics of the subject, *i.e.* we want to study measures of the similarity or dissimilarity of what we may perhaps call "resemblant contours."

KARL PEARSON.

Biometric Laboratory, London, February 11.

The Mnemic Theory of Heredity.

IF it were explained clearly in what respects an "acquired" character is more acquired and less innate, germinal, and inherited than an "inborn" trait, a real service would be rendered to science, and, possibly, a controversy which at present seems interminable might be ended. A unicellular organism distributes itself between its daughter-cells. Here, obviously, there is actual inheritance; and, if the acquirements of the parents persist in the offspring, there is inheritance of acquirements. But a multicellular organism does not distribute itself. It is a cell-community, and, so far as is known, offspring are derived not from it as a whole, but from particular members of it—the germ-cells. There is thus no inheritance from the "parent" in the sense that there is inheritance among unicellular types. For example, the child does not inherit the parent's nose, leaving the parent derelict. The latter keeps the whole of his nose for himself.

The germ-cell is a bundle of potentialities for development. It develops into an animal or plant of the species whence it is derived under the influence of various stimuli—food, temperature, light, moisture, internal secretions, use, injury, and the like. Thus in man one kind of stimulus causes a hand to develop, another a scar, a third a use-callosity. Nothing develops in the individual, nothing can develop, unless both the potentiality and the appropriate stimulus are present. All kinds of potentialities are equally products of evolution, and are equally rooted in the germ-plasm. Thus the potentiality to develop a scar is as much a part of the germ-plasm as the potentiality to develop a head. Some characters develop more certainly than others, but this is only because the stimulus (not the potentiality) under which they grow is more certainly present. Thus a head develops more certainly than a particular scar, but the scar would develop as certainly as the head were its stimulus (a particular injury) as constantly present. In man the scar left by the destruction of the umbilical cord is as constant as the head.

It is customary to term traits which develop under the stimulus of use and injury acquired, while all others are called inborn. But if all potentialities are equally present in the germ-cell, if all characters are alike products of a reaction between internal potentiality and external stimulus, what is the peculiarity that makes one kind of character more inborn and inheritable than another? As far as I am able to judge, the Lamarckian controversy has been conducted on the basis of a misuse of terms, or on the (at present unwarrantable) assumption that the multicellular organism is derived from its parent in the same sense as a unicellular is derived, or under the belief (also unwarrantable) that the only characters that arise in response to stimulus from the environment are those which grow through the influence of use and injury. I am able to understand, for instance, how a negro who has a scar differs both innately and by acquirement from a white man who has no such scar. His potentialities are different, and therefore he differs innately; the stimuli to which he was exposed differed, and therefore he differs by acquirement. But it is one thing to apply these terms to likenesses and differences between individuals and another to apply them to characters as such. I take it that the words "inborn," "acquired," and "inheritable" have been illegitimately transferred from a connection in which they have meaning to a connection where they are unintelligible: for can anyone state precisely in what sense the skin colour of a negro is more innate or germinal than his scar?

When it is maintained that "acquirements are transmissible," it is held, in effect, that characters (*e.g.* scars and use-callosities) which the parent was able to acquire in a certain way (as reactions to injury and use), because a long course of evolution had rendered such acquisitions possible to members of his species, tend, at the time of observation, to be reproduced by the offspring in a different category of characters and in ways (as reactions to other stimuli) in which no ancestor had acquired them before, and with which, therefore, evolution had nothing to do. The evidence on which we are asked to accept this improbable supposition is usually equivocal, and, in recent times, invariably such as cannot easily be verified.

But turn to common experience. Facts are not the less valuable or certainly true because they are familiar. Take characters which develop under the stimulus of use, or, what in the case of mind is the same thing, experience. The development of some physical and mental traits, for example, the hair, the teeth, external ears, reflexes, and instincts, is not influenced by this stimulus. Other characters, for instance, in man, the limbs, heart, kidneys, brain, and all that is learnt, all that is intellectual, owe their growth after birth mainly to it. Such characters tend to atrophy when disused or little used, and to hypertrophy when much used. Low in the scale of life, animals develop less under the influence of use and more under other stimuli. But all the higher animals, in proportion as they are highly placed, impelled by an instinct, sport during youth, and thus stimulate mind and body to the acquisition of traits without which maturity is incomplete. Parental care after the beginning of conscious life is an adaptation the function of which is to afford time and opportunity for the acquisition of use-acquirements. It is not found low in the scale of life among animals that, at each stage, come ready armed by "inborn traits" to the struggle for existence, and is most elaborate and prolonged among the highest types. We call an animal intelligent in proportion as it is capable of profiting from experience. A human idiot is nothing other than an individual who, reverting to a remote ancestral type, has lost the power of growing mentally under the influence of experience.

Manifestly the so-called acquirements are more advantageous as responses to injury and use than they would be if they grew in response to the more unvarying stimuli. As they are, they render the animal adaptable, capable of fitting himself to a diversity of environment. Compare the adaptability of a man with that of a beetle. Manifestly also "inborn traits" have undergone great retrogression and use-acquirements great progression in the higher animals, which, presumably, are derived from lower types. It follows that, while a supposition that "inborn traits" tend to be transmuted into "acquirements" might be maintained with some appearance of plausibility, the contrary Lamarckian doctrine that "acquirements" tend to be transmuted into "innate traits" is untenable. The mnemic hypothesis does not demonstrate the transmission of acquirements. It merely makes confusion worse confounded by misusing another word. According to it, the germ-cell remembers that which it never knew, and forgets that which it knew.

Southsea, February 17. G. ARCHDALL REID.

THE reply to Prof. Dendy's comments upon my letter (NATURE, February 8, p. 482) is briefly as follows. The germ-cells are unicellular *living organisms* with a life-cycle of their own, part of which they pass in a metazoan individual. When they enter it, they are all in potentialities so many twins identical with this. For the time being its environment is theirs. The non-existent protoplasmic bridges need not be postulated. If the germ-cells could not "remember events in the past history of the race," I fail to perceive how any developmental unfolding would be possible. The relation of the doctrine of acquired characters to the theory depends solely upon the embryological facts of the cycle of animal life.

The enormous distinction between animals and plants regarding the problems under discussion is brought about primarily by the fact that in plants *the asexual generation* has undergone increased evolution, in animals *the sexual generation*. I might, indeed, have cited the peach tree, quoted by Prof. Dendy, instead of the chrysanthemum. Peach trees, as anyone who tends a garden knows, are reproduced *asexually by grafts*, and not *sexually* from seed, as Prof. Dendy assumes. The reason is simply that peach trees do not "come true" from seed. Probably the evergreen condition would not be repeated from seed. Coming true in grafts, this is a good example of my contentions.

A true theory of heredity, like the mnemic one, must be founded in a correct embryology, and this theory of Hering's is the sole one which can be shown to conform with the facts of the cycle of animal life. All other theories known to me are based in direct development—an impossibility. In developmental researches, which extend back so far as 1888, antithetic alternation of generations has proved itself to be the only possible mode of animal development. Moreover, this is in accord with Pasteur's fundamental researches establishing the stereochemistry of naturally occurring organic compounds. Those who with Weismann and Haeckel hold to direct development, or any theories of heredity based on this, live in a universe in which there is no science of stereochemistry, and in which the naturally occurring organic compounds have no action upon the plane of polarised light.

Nor do identical twins arise as Weismann supposed. The whole "evolution theory" of Weismann is full of such baseless hypotheses. If ordinary identical twins (AB, AB) arise so, how do the rarer ones (AB, BA), where the one is the looking-glass image of the other, externally and internally, come about? Or how are identical triplets produced, or the seven to twelve identical embryos from a single egg in the seven-banded armadillo, *Praopus hybridus*? Embryo or sexual generation does not, as is so generally believed, ever arise by the first few divisions of the egg. The facts and reasons contained in this and my former letter—though they do not profess to be all the pertinent facts—may serve to indicate why a correct appreciation of the cycle of animal life is so important for all theories of heredity, and, one might also add, for all theories of the origin and nature of cancer. For under current false theories of development cancer is "an incurable disease," whereas in the light of a true embryology and in that of stereochemistry it is *a natural phenomenon*, which Nature has demolished for untold millions of years, and which man also can cope with and destroy whenever he sees fit to imitate her and to use her methods. J. BEARD.

8 Barnton Terrace, Edinburgh, February 15.

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(1) I QUITE agree with Dr. Reid that the mnemic hypothesis does not demonstrate the transmission of acquirements. What I said in my review was that the mnemic theory is based upon a belief in the inheritance of acquired characters—a statement that anyone may verify who will take the trouble to read Prof. Semon's book. I should perhaps have qualified the statement by saying "Prof. Semon's Mnemic Theory," though personally I cannot conceive of a mnemic theory which is not so based.

The inheritance or non-inheritance of acquired characters is, of course, still an open question, but it is interesting to reflect that such inheritance was assumed as a matter of course by the great founders of the theory of organic evolution—Buffon, Erasmus Darwin, Lamarck, and Charles Darwin—and was never called in question until the latter part of the nineteenth century. Before that time no one thought it necessary to make experiments to prove or disprove what everybody believed; since then there has not been time to make anything like enough experiments, but some of those which have been made certainly seem to indicate the possibility of the inheritance of acquired characters in the strictest sense of the term. It is not a question which can be answered dogmatically or by any amount of *a priori* argument. It was just as reasonable for Lamarck and others to suppose that such characters can be inherited as it is for Weismann and his followers to suppose that they cannot. Let us wait and see what the future may bring forth.

(2) IF Dr. Beard will read the review which gave occasion for his first letter, he will find it plainly stated that the peach trees in Bordage's experiments were raised from seeds. Had they been raised in the ordinary way from grafts there would, of course, have been no point in the observations, and I certainly should not have thought it worth while to direct attention to them.

I suppose all upholders of the mnemic theory will agree that if the germ-cells could not remember events in the past history of the race, no developmental unfolding would be possible. The important point seems to be that the events in question have, for the most part at any rate, been experienced by the body and not by the germ-cells, and that unless the germ-cells received information of them from the body they could not remember them at all. This view necessarily assumes that the body is able to transmit impressions to the germ-cells, which, as I said before, is the fundamental idea of the doctrine of the inheritance of acquired characters. The experiences of the body are supposed to depend, in the first instance at any rate, upon the environment, and to give rise to "acquired" characters, and such characters, according to the mnemic theory, influence the germ-cells and are transmitted by them to the bodies of future generations.

I do not propose to discuss Dr. Beard's views on animal development, but I think it ought to be clearly stated that the mnemic theory, as ordinarily understood, is entirely independent of any such views. If Dr. Beard has a mnemic theory of his own that is another matter, but it might be well to call it by some other name.

ARTHUR DENDY.

How Pollen is Collected by the Honey-bee.

ON February 11, a mild and sunny day, my bees were working busily on *Eranthis hiemalis*, the winter aconite, and by watching them I was able to verify my opinion, published in *The British Bee Journal* of December 14, 1911, that the pollen is collected by being scraped into the fissure between the tibia and metatarsus, and is compressed and forced out into the "corbicula," or pollen-basket, on the outside of the tibia by the closing of the fissure, a conclusion suggested by the examination of the hind leg of a queen humble-bee.

One bee was watched for more than five minutes rifling flower after flower. During this time the load of pollen in each corbicula increased in size considerably, but the bee did not once cross its legs and scrape the pollen-laden metatarsal brushes on the upper edges of the opposite tibiæ, which was the way that Cheshire supposed the corbicula was loaded ("Bees and Bee-keeping," vol. i., p. 132). On the other hand, the inner sides of the metatarsi were frequently rubbed together, *the motion being longitudinal*, and it was evidently by this rubbing or scraping that the corbiculæ were loaded, for the hind legs did not come into contact with one another in any other way.

Several other bees were watched, and were found to behave in exactly the same manner. In all cases the pollen was gathered on to the metatarsal brushes direct from the anthers as the result of the bee crawling about amongst the stamens.

My observations were hampered by a gusty wind, which disconcerted the bees, and they were soon brought to a close by the sunshine passing off the flowers, so that several points that I had hoped to clear up still remain obscure.

One of these is the way in which the pollen dust is moistened with nectar. The only satisfactory manner in which, it seems to me, this can be done is for the tongue to lick the tarsi or metatarsi of the fore legs, which are covered with stiff bristles well suited for holding the nectar, the nectar being then transferred to the metatarsal brushes on the middle legs, and from these, again, to the metatarsal brushes on the hind legs. The latter being thus rendered sticky, the pollen dust would cling to them. The different pairs of legs were certainly brought together occasionally, but not after every scrape of the hind metatarsi, and their movements were so quick that it was impossible to see what was done. Still, several pollen-collecting bees that I killed had the tarsi and metatarsi of the fore legs and the metatarsal brushes of the middle and hind legs moistened with nectar, and I think it probable

that the moistening process, as outlined, is performed, as a rule, during the flight from flower to flower. Indeed, upon reflection, one feels convinced that this would be the most convenient interval in the ceaseless work of the proverbially busy bee for performing this function, while at the same time the instinct to do it then, once acquired, would ensure its accomplishment when and as often as necessary. I intend to dust with flour the hind metatarsi of bees entering flowers, and also those of bees leaving flowers. If the former retain more flour than the latter, the theory that the moistening takes place during the flight from flower to flower will be demonstrated.

Probably the kinematograph will be able before long to reproduce the whole process of pollen-collecting at a speed slow enough to be followed by the human eye.

Ripple, Dover. F. W. L. SLADEN.

Microscope Stands.

MR. J. W. OGILVY, in his reply (NATURE, February 8) to one of my questions, does little more than reiterate his former statement that the German instruments are superior, and are produced in better organised works. This seems to introduce the question of workmanship, which has not, to my knowledge, been brought under consideration. The discussion seems to be one of design.

Mr. Ogilvy also appeals for proof of superiority to the number of Continental instruments in the various technical laboratories. Even if the number in use is larger, this cannot be accepted as proof of their superiority. The number of chromatic "Abbe" condensers must be much larger than of other condensers, but this does not prove that it is the best condenser. I do not think it has been proved that the most intelligent users are to be found in the various technical laboratories. The last paragraph of "F.R.M.S.'s" letter is proof of what I mean.

Now, with regard to the sprung fittings, Mr. E. M. Nelson, writing in the current issue of *The English Mechanic*, says:—"I have always considered springing to be a most important point in microscope construction."

The question seems to be this: "Which instrument, the English or the Continental, is, by virtue of its design and workmanship combined, capable of affording the scientific worker the greatest facilities for work of a critical character?"

I venture to think that the answer to this question by our most eminent workers would not be so much in favour of the Continental type as Mr. Ogilvy seems to imagine.

Boston Spa, near Leeds. JOHN A. L. SUTCLIFFE.

As the writer of a letter on "Microscope Stands" in NATURE of February 22, I wish to add that the term "Continental firm" used in connection with the remarks on horseshoe base with extended rear toe, mechanical stage on a rotating principle, and machined slide bearings should include the American manufacturer.

F. R. BRAND.

Meteor-showers.

THE following meteor-showers become due in March; their arrangement is according to the principal maxima:—

Epoch March 1, 12h. (G.M.T.), fifth order of magnitude. Principal maximum, March 2, 13h. 5m.; secondary maximum, March 1, 9h. 30m.

Epoch March 5, 20h. 30m., eighteenth order of magnitude. Principal maximum, March 4, 12h. 35m.; secondary maxima, March 4, 9h. 30m. and 19h. 35m.

Epoch March 5, 21h., twenty-fifth order of magnitude. Principal maximum, March 6, 7h.; secondary maximum, March 5, 0h. 30m.

Epoch March 9, 22h. 30m., twenty-second order of magnitude. Principal maximum, March 8, 20h. 45m.; secondary maximum, March 8, 3h. 30m.

Epoch March 9, 3h. 30m., ninth order of magnitude. Principal maximum, March 9, 19h. 50m.; secondary maximum, March 9, 20h. 40m.

Epoch March 11, 8h. 30m., first order of magnitude. Principal maximum, March 10, 23h. 10m.; secondary maxima, March 10, 0h. 5m. and 16h. 50m.

Epoch March 12, 13h., ninth order of magnitude. Principal maximum, March 12, 12h. 50m.; secondary maximum, March 11, 13h. 40m.

Epoch March 13, 16h., twentieth order of magnitude. Principal maximum, March 13, 1h.; secondary maximum, March 12, 8h. 50m.

Epoch March 19, 22h., tenth order of magnitude. Principal maximum, March 18, 17h. 45m.; secondary maximum, March 18, 9h. 10m.

Epoch March 21, 10h., eighteenth order of magnitude. Principal maximum, March 19, 14h. 30m.; secondary maxima, March 17, 19h. 25m., and March 18, 4h. 30m.

Epoch March 19, 2h., approximately second order of magnitude. Principal maximum, March 20, 15h.; secondary maxima, March 19, 6h. 50m., and March 22, 10h. 50m.

Epoch March 22, 2h. 30m., tenth order of magnitude. Principal maximum, March 22, 3h. 20m.; secondary maxima, March 23, 10h. 25m. and 22h. 45m.

Epoch March 23, 21h., thirtieth order of magnitude. Principal maximum, March 24, 17h. 30m.; secondary maximum, March 26, 12h. 55m.

Epoch March 26, 14h., eighteenth order of magnitude. Principal maximum, March 26, 5h. 40m.; secondary maxima, March 26, 2h. 20m. and 11h. 30m.

Epoch March 27, 14h. 30m., twentieth order of magnitude. Principal maximum, March 27, 10h.; secondary maximum, March 27, 4h.

Epoch March 27, 4h. 30m., approximately first order of magnitude. Principal maximum, March 28, 22h. 45m.; secondary maxima, March 27, 12h. 10m., and March 28, 6h.

Though meteor-displays are distributed, apparently, pretty evenly over the month, yet there are periods of special intensity. These periods, which are four in number, comprise the dates March 2–4, March 9–13, March 20–22, and March 26–28. Heavy meteor-falls are due on the nights of March 2 and 4.

Dublin. JOHN R. HENRY.

EXAMINATIONS IN SECONDARY SCHOOLS.[1]

THE Consultative Committee of the Board of Education has, for the second time, made a report on examinations in secondary schools, and, though opinions may differ as to the precise value of the recommendations which the committee now makes, everyone must congratulate the members on the valuable information they have collected and the clearness with which they have shown once more the existence of a great evil, and the arguments for and against various methods of dealing with it. The report which the committee made seven years ago has been followed by a small improvement, but secondary education in this country still groans under the burden of a needlessly complicated system of examinations, which are the cause of the gravest injury, not only to secondary schools, but to all branches of higher education which depend so largely on the foundation laid in these schools.

One of the saddest points brought out in the report is the extent to which young children are at present submitted for examinations, notwithstanding the efforts of the Board of Education and certain local education authorities to prevent this. Thus a return supplied by the Lancashire Education Committee shows that nearly half of 1070 pupils of certain schools in the county submitted for external examinations during a given year were below the age of sixteen. Unfortunately, the ancient Universities of Oxford and Cambridge are amongst the greatest offenders in the matter of providing such examinations, for it appears that in their local examinations alone more than 20,000 children under sixteen were examined in 1908.

It is shown that the results of these examinations are largely used, more particularly by inferior schools, as a means of advertisement, and that this system is aided by the ancient universities by an arrangement

[1] Report of the Consultative Committee of the Board of Education on Examinations in Secondary Schools. Cd. 6004. (Wyman and Sons.) Price 2s. 6d.

by which, in their preliminary examinations, children under fourteen years of age can gain "distinctions" in individual subjects! As Mr. Paton, the high-master of the Manchester Grammar School, points out, "the endorsement of a certificate with the name of a university of national repute raises quite a false assumption of academic attainment."

Unfortunately, examinations of this kind for which a large number of candidates submit themselves are paying concerns; they are not only a source of income to the examiners employed, but the bodies which conduct them also make a considerable annual profit.

The report proves conclusively that the examinations as at present conducted are a source of at least as much (probably more) harm than good. The influence of these external examinations on the school curriculum is often distinctly bad; bookish subjects which can be easily examined get more credit than subjects of importance, such as handicraft for boys and cookery for girls, which are not readily brought into the examination net.

Not only is the curriculum damaged, but the teaching is also injured, and experiments are made difficult. If it is asked: "Why, then, do not the best teachers decline to prepare for these examinations?" the answer is that too many parents gauge the success of a school by its examination results, that many boys and girls must pass these examinations in order to qualify for the work they mean to undertake on leaving school, and that, if the schools declined to prepare for them, it would simply result in the children being forced to go to a "crammer," and so to lose such benefits as the examination system still allows the secondary schools to offer.

The subjects on the modern side of a school suffer more particularly, since existing schemes of examination tend to lessen the importance of a good knowledge of modern languages and of practical work in science. Instances are by no means uncommon when a teacher of science, in the interest of pupils who must pass a certain examination, is obliged to let them spend the time which ought to be devoted to practical work in "reading up" for the written examination. In but very few examinations is any credit given for the practical work done throughout the session. Even when a practical examination is held, it is of little use, since it can only test to a very small extent the examinee's aptitude for practical work and his understanding of the results which he obtains.

In literary subjects also the influence of the present examination system is often bad. A teacher cannot adopt what he considers the best methods, but must always have an eye to the kind of questions which the examiner, who is seldom in touch with him, is likely to set.

While the Universities of Oxford and Cambridge are probably mainly responsible for the present vicious system, it must be remembered that, as the committee points out, their objects were, and no doubt still are, undoubtedly good. They started these examinations at a time when the secondary schools of the country sadly needed guidance, both as to what should be taught and as to the standard of knowledge which their pupils ought to attain.

The modern universities are by no means blameless in the matter. With the exception of the northern universities, which have, fortunately, been compelled to adopt a common matriculation examination, each new university has taken its own view as to what its requirements for entry should be. It is true that they have adopted systems of "equivalents," but in no two cases are these "equivalents" alike, so that a boy or a girl who goes to school, say, in Birmingham, and whose parents move to London or Manchester at the age when the child is fit to enter a university, may very well find that, while the child is qualified for entry to the University at Birmingham, he cannot be admitted either at Manchester or in London without a further examination. Surely the time has come when, as in other civilised countries, there should be a school certificate which all the universities should be compelled to accept as qualifying for admission to their courses for a first degree.

But when the schools have provided for the requirements of the universities, they have only dealt with a small proportion of their pupils. The various professional bodies have various requirements for the admission of students. These are not always the same as those required by the universities; thus the Institution of Civil Engineers lays down conditions which can but rarely be fulfilled by boys who have attended schools where the training is mainly of a literary character; for the intending student must have passed his qualifying examination in more advanced mathematics and science. Why should a boy with distinct mathematical and engineering ability be shut out simply because his father has happened to send him to a classical school? By all means require him to give evidence in later examinations that he has the requisite amount of mathematical and scientific knowledge to enable him to become a competent engineer, but why block his way at entrance? The question ought not to be at this stage what the boy has learnt, but whether he has learnt it well, and whether his mind has been trained to be receptive of fresh knowledge.

Then, in addition to the requirements of the universities and professional bodies, we have the paradise of crammers provided by the Civil Service examinations. No doubt for many branches of the Civil Service special examinations are necessary, but for all except certain subordinate posts a certificate of the satisfactory completion of a secondary course should be regarded as an essential qualification. This is the case in Germany, though the Abiturienten Examen represents a longer period of training in a secondary school and a higher standard of attainment than the school certificate which the committee advocates.

If such a preliminary qualification were accepted, it would only be necessary for the Civil Service Commissioners to hold examinations in certain special subjects required by the various public departments.

The most important recommendations made by the committee are:—(1) in regard to a secondary-school certificate; (2) in regard to a secondary-school testamur; and (3) in regard to an examinations council to whom would be entrusted powers to carry into practice the principles which the committee favours.

The secondary-school certificate is to be issued to pupils not less than sixteen years of age; it is to be of approximately the same standard as the present matriculation examination, but is to be awarded not merely on written work, but partly on inspection, on an examination of the whole of the work done by the pupils, and on the marks given for such work by the teachers, who would have a consultative voice in the award of the certificate. This proposal involves a great improvement on the present chaotic system; but it represents only a step in the right direction.

It is unfortunate that in this country the majority of the pupils in secondary schools leave at about the age of sixteen or earlier, while in both Germany and America a far larger proportion remain at school until about the age of eighteen. For from this results a further drawback that, while the usual age of admission to German and American universities and technical high schools is not less than eighteen, the modern universities in this country and the technical colleges are obliged to fix their minimum age of

admission at sixteen, and so to do in the early part of their courses work which might very well be left to the secondary schools. It is, therefore, desirable that the age for the award of the secondary-school certificate should be gradually raised to eighteen, as Great Britain slowly awakes to the need of education, in order to enable us to compete on equal terms with foreigners. But at present this would be a useless counsel of perfection.

The secondary-school testamur is to be given to pupils of about the age of fifteen, and the committee suggests that great care should be taken to distinguish it "both in name and value from the secondary-school certificate." But this will be extremely difficult, and to give an alternative certificate of this kind will probably damage education in several ways. It will offer an inducement to a still larger number of pupils to leave secondary schools even earlier than they do at present. A not inconsiderable portion of the general public may very well think that a "testamur," which is a word less known to them than "certificate," is a thing of at least as great value; for to them *omne ignotum pro magnifico est*. There would be less objection to the proposed testamur if and when the certificate was given at the age of about eighteen, for there would then be a sufficiently wide gap between the standards to prevent the possibility of confusion.

The committee's suggestions in regard to the examinations council are, however, the most important. This council is to be of a representative character, including not only persons of educational experience, but also some with a knowledge of what is wanted by recruits for the professions, commerce, or industrial life. On the educational side there would be representatives of the Board of Education, the universities, the local authorities, and teachers in different kinds of schools.

The council would be entrusted with the important duty of regulating external examinations in secondary schools aided by the Board of Education, and would derive its power from the fact that no such school would be allowed to enter its pupils for external examinations other than those which the council conducted or approved. The inspectors of the Board of Education would place their experience at the disposal of the examinations council, so that the work of examination and inspection might be properly co-ordinated.

There can be little doubt that the formation of such a council would be of the greatest possible service, provided, of course, Parliament gave it sufficient authority to ensure that its decisions were respected. But the committee thinks that as a preliminary step the existing examining bodies might be asked by the Board of Education to confer together in order to see whether, by mutual consent, steps can be taken to bring about the state of affairs which the committee desires. It is very doubtful whether such a conference would meet with any considerable measure of success, though it is just possible that if, before convening the conference, the Board of Education made it evident that the existing examination swamp must be cleared, the examining bodies might find it expedient to agree to an amalgamation. For some of the vested interests could be considered; the majority of the existing examiners would probably be still employed, and even the officials and clerical staffs might be taken over by the new examinations council.

The committee wisely advises that, if the proposed conference be held, and it is found that those concerned will not voluntarily agree to modifications of the present system on the lines indicated, the Board should not consider itself to be relieved of responsibility, but should proceed to the formation of a representative examinations council with the powers mentioned above.

All the members of the committee signed the report with the single exception of Mr. Jackman, who objects to the proposals mainly on the ground that pupils in elementary schools will not be able to obtain the secondary-school certificate, and may, therefore, find their path to promotion barred. Some years ago this argument would have had considerable weight, for the "free place" system had not then come into being. Now, however, many pupils of the secondary schools come from the elementary schools, and it may fairly be said that in a large part of the country no bright child in an elementary school is precluded by poverty from the advantages of secondary education. If it be alleged that there are other parts of the kingdom where such exclusion takes place, then, surely, it would be better to take steps to modify this state of affairs rather than to block a most important reform affecting not merely secondary but also higher education. It is to be hoped, therefore, that the majority of teachers in elementary schools will not oppose the proposals set forth in the report of the committee, which bears the signature of Mr. Sharples, a respected member of their profession, who would not support any system likely to injure either elementary schools or their pupils.

J. WERTHEIMER.

THE PRISM-BINOCULAR.

ONE of the many revolutions which have been quietly proceeding in the last few years has been the introduction of the prism-binocular in place of the old form of opera- or field-glass. In 1851 an Italian, Ignatius Porro, devised a very ingenious and yet simple arrangement of prisms by which the simple astronomical telescope might yield an erect image. An instrument was constructed with these prisms by Boulanger, in 1859, and again in 1875 by Nachet, the firm so well known in connection with the binocular microscope. Neither of those makers succeeded in making it popular, however, probably partly because of the quality of the glass of which the prisms were made, and partly because the prisms were not well enough worked to give good images—the light is four times reflected, and it is obvious that if the reflecting faces are not all perfectly flat the definition will be seriously impaired. In 1893 Ernst Abbe designed an instrument, making use of the new glass obtained by Schott; the resulting "prism-binoculars" made under the modern conditions were an immediate success. The faces of the prisms are tested by Newton's bands of colour. These bands must be perfectly straight right up to the edge. The refracting surfaces are tested, as well as the reflecting, though perfection of the latter is the more important.

The advantages of the new form of opera-glass over the old are the great field of view and depth of focus, with a higher power. The image is not quite so bright, and therefore for night work the old form is best. In the old form, the field of view depends on the diameter of the objective as imaged by the eye-lens, and with even a moderate power the diameter has to be large; thus the glasses are clumsy. In the new form the field is independent of the diameter of the objective, and when there is plenty of light the latter can be made quite small.

The new glasses are made by several firms, and we have recently had the pleasure of inspecting some of the models made by the firm of Leitz, with magnifications ranging from four diameters upwards. The chief feature which their glasses possess over others, we have seen, is their lightness, due to the construction of the bodies of nickel-steel tubes, which

by which, in their preliminary examinations, children under fourteen years of age can gain "distinctions" in individual subjects! As Mr. Paton, the high-master of the Manchester Grammar School, points out, "the endorsement of a certificate with the name of a university of national repute raises quite a false assumption of academic attainment."

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The most important recommendations made by the committee are:—(1) in regard to a secondary-school certificate; (2) in regard to a secondary-school testamur; and (3) in regard to an examinations council to whom would be entrusted powers to carry into practice the principles which the committee favours.

The secondary-school certificate is to be issued to pupils not less than sixteen years of age; it is to be of approximately the same standard as the present matriculation examination, but is to be awarded not merely on written work, but partly on inspection, on an examination of the whole of the work done by the pupils, and on the marks given for such work by the teachers, who would have a consultative voice in the award of the certificate. This proposal involves a great improvement on the present chaotic system; but it represents only a step in the right direction.

It is unfortunate that in this country the majority of the pupils in secondary schools leave at about the age of sixteen or earlier, while in both Germany and America a far larger proportion remain at school until about the age of eighteen. For from this results a further drawback that, while the usual age of admission to German and American universities and technical high schools is not less than eighteen, the modern universities in this country and the technical colleges are obliged to fix their minimum age of

admission at sixteen, and so to do in the early part of their courses work which might very well be left to the secondary schools. It is, therefore, desirable that the age for the award of the secondary-school certificate should be gradually raised to eighteen, as Great Britain slowly awakes to the need of education, in order to enable us to compete on equal terms with foreigners. But at present this would be a useless counsel of perfection.

The secondary-school testamur is to be given to pupils of about the age of fifteen, and the committee suggests that great care should be taken to distinguish it "both in name and value from the secondary-school certificate." But this will be extremely difficult, and to give an alternative certificate of this kind will probably damage education in several ways. It will offer an inducement to a still larger number of pupils to leave secondary schools even earlier than they do at present. A not inconsiderable portion of the general public may very well think that a "testamur," which is a word less known to them than "certificate," is a thing of at least as great value; for to them *omne ignotum pro magnifico est*. There would be less objection to the proposed testamur if and when the certificate was given at the age of about eighteen, for there would then be a sufficiently wide gap between the standards to prevent the possibility of confusion.

The committee's suggestions in regard to the examinations council are, however, the most important. This council is to be of a representative character, including not only persons of educational experience, but also some with a knowledge of what is wanted by recruits for the professions, commerce, or industrial life. On the educational side there would be representatives of the Board of Education, the universities, the local authorities, and teachers in different kinds of schools.

The council would be entrusted with the important duty of regulating external examinations in secondary schools aided by the Board of Education, and would derive its power from the fact that no such school would be allowed to enter its pupils for external examinations other than those which the council conducted or approved. The inspectors of the Board of Education would place their experience at the disposal of the examinations council, so that the work of examination and inspection might be properly co-ordinated.

There can be little doubt that the formation of such a council would be of the greatest possible service, provided, of course, Parliament gave it sufficient authority to ensure that its decisions were respected. But the committee thinks that as a preliminary step the existing examining bodies might be asked by the Board of Education to confer together in order to see whether, by mutual consent, steps can be taken to bring about the state of affairs which the committee desires. It is very doubtful whether such a conference would meet with any considerable measure of success, though it is just possible that if, before convening the conference, the Board of Education made it evident that the existing examination swamp must be cleared, the examining bodies might find it expedient to agree to an amalgamation. For some of the vested interests could be considered; the majority of the existing examiners would probably be still employed, and even the officials and clerical staffs might be taken over by the new examinations council.

The committee wisely advises that, if the proposed conference be held, and it is found that those concerned will not voluntarily agree to modifications of the present system on the lines indicated, the Board should not consider itself to be relieved of responsibility, but should proceed to the formation of a representative examinations council with the powers mentioned above.

All the members of the committee signed the report with the single exception of Mr. Jackman, who objects to the proposals mainly on the ground that pupils in elementary schools will not be able to obtain the secondary-school certificate, and may, therefore, find their path to promotion barred. Some years ago this argument would have had considerable weight, for the "free place" system had not then come into being. Now, however, many pupils of the secondary schools come from the elementary schools, and it may fairly be said that in a large part of the country no bright child in an elementary school is precluded by poverty from the advantages of secondary education. If it be alleged that there are other parts of the kingdom where such exclusion takes place, then, surely, it would be better to take steps to modify this state of affairs rather than to block a most important reform affecting not merely secondary but also higher education. It is to be hoped, therefore, that the majority of teachers in elementary schools will not oppose the proposals set forth in the report of the committee, which bears the signature of Mr. Sharples, a respected member of their profession, who would not support any system likely to injure either elementary schools or their pupils.

J. WERTHEIMER.

THE PRISM-BINOCULAR.

ONE of the many revolutions which have been quietly proceeding in the last few years has been the introduction of the prism-binocular in place of the old form of opera- or field-glass. In 1851 an Italian, Ignatius Porro, devised a very ingenious and yet simple arrangement of prisms by which the simple astronomical telescope might yield an erect image. An instrument was constructed with these prisms by Boulanger, in 1859, and again in 1875 by Nachet, the firm so well known in connection with the binocular microscope. Neither of those makers succeeded in making it popular, however, probably partly because of the quality of the glass of which the prisms were made, and partly because the prisms were not well enough worked to give good images—the light is four times reflected, and it is obvious that if the reflecting faces are not all perfectly flat the definition will be seriously impaired. In 1893 Ernst Abbe designed an instrument, making use of the new glass obtained by Schott; the resulting "prism-binoculars" made under the modern conditions were an immediate success. The faces of the prisms are tested by Newton's bands of colour. These bands must be perfectly straight right up to the edge. The refracting surfaces are tested, as well as the reflecting, though perfection of the latter is the more important.

The advantages of the new form of opera-glass over the old are the great field of view and depth of focus, with a higher power. The image is not quite so bright, and therefore for night work the old form is best. In the old form, the field of view depends on the diameter of the objective as imaged by the eye-lens, and with even a moderate power the diameter has to be large; thus the glasses are clumsy. In the new form the field is independent of the diameter of the objective, and when there is plenty of light the latter can be made quite small.

The new glasses are made by several firms, and we have recently had the pleasure of inspecting some of the models made by the firm of Leitz, with magnifications ranging from four diameters upwards. The chief feature which their glasses possess over others, we have seen, is their lightness, due to the construction of the bodies of nickel-steel tubes, which

are thin and therefore light, and yet rigid and strong. One of these is a pretty little pair for ladies' use, weighing only six ounces, in a dainty case (fitted with a mirror and a small pocket), which yet has a magnification of four diameters, and an angular field of view of 11°, equivalent to a field 193 yards wide at 1000 yards. These are greater than would be obtained by an old pattern opera-glass of large size, and are very much greater than the magnification and field of the small ones usually carried by ladies, for which the former is often only two or three diameters. Even with the case the weight is but thirteen ounces.

A corresponding glass of the same power and aperture is also made for field use. In addition to the central focussing screw one of the eye-lenses has an independent focussing adjustment for correcting any difference in refraction between the eyes of the observer.

Another glass very suitable for all-round use, magnifying six diameters and weighing a pound, gives good definition over a field of 8°. To see the whole field at once, however, the eye has to be put uncomfortably close to the eye-piece; in ordinary use the field may be taken to be about six or seven degrees.

The brightness of the image depends upon the aperture of the objective (of course, also on the absorptions of the glass of the prisms and lenses, and the internal reflections). Leitz makes two models magnifying eight diameters, the one of which has an objective one inch in diameter; the other has a diameter of one and a quarter inches; with a centre focussing screw, they weigh eighteen and twenty-three ounces respectively without the case. The larger one gives a much brighter image, but this, as stated above, is unnecessary in ordinary circumstances. It is intended to be used at dusk; it is an ideal glass for a naturalist, for instance, for watching wild life in a dark wood. It is dust- and damp-proof.

High powers require a steady hand to get their full value; the eight-diameter can be used comfortably by most people, especially if the arm or elbow can be supported. But powers above this magnify the tremors of the hand so much that they are only of use for special work. Leitz makes ten-diameter and twelve-diameter models. These have large objectives and remarkably high luminosity of image; for their power their angular field is also high.

PROF. OSBORNE REYNOLDS, F.R.S.

IN Prof. Osborne Reynolds, whose death took place on February 21 at Watchet, Somersetshire, Great Britain has lost its most distinguished scientific engineer. He was born at Belfast on 1842, but spent his childhood in Suffolk, where his ancestors had, for generations, been rectors at Debach and Boulge. Having received his school education at Debenham, he entered Queen's College, Cambridge, and after a brilliant academic career, became a fellow of his college in 1867.

The chair of civil and mechanical engineering at the Owens College was founded a year later on the initiative of the leading engineers of the Manchester district, and endowed by them. A committee, on which were such men as William Fairbairn and Joseph Whitworth, selected Reynolds as the first occupant of the professorship. The foundation of the Whitworth scholarships, ten of which were reserved for Manchester students, immediately followed, and greatly assisted the early work of the School of Engineering. It is of interest to note the names of John Hopkinson and J. J. Thomson among the students who received their instruction from Osborne Reynolds. Practical instruction in engineering was unknown, when engineering was first included among the subjects taught at university colleges, and it was not until Reynolds had held his chair for nearly twenty years, that funds became available for the building of a laboratory. The Whitworth Laboratories at Manchester and Sir Alexander Kennedy's laboratory at University College were the first of their kind, and served as models for other similar institutions throughout the country.

During a period of over thirty years Reynolds was actively engaged in scientific work, including in his wide field of investigation many important problems of engineering and physics. Well in advance of his time, in many cases years elapsed before the practical bearing of his researches was fully appreciated; even now the sphere of his influence on engineering progress is still widening.

In 1874 Reynolds published his first papers on "Heat Transmission," in which he showed that in most practical cases the motion of the gas, and not its conductivity, was the controlling factor. Nearly thirty years later, the attention of engineers was directed to this work by Perry, and the principle applied to boiler construction by Nicholson and others.

Experimenting with steam, Reynolds found that in the absence of any admixture of air, the rate of condensation was practically unlimited, and he studied the effect of air on the cooling surface required, and the efficiency of the condenser. Very high vacua are not required for the ordinary reciprocating engine, and it was only in recent times, and owing to the introduction of the steam turbine, that the theory of condensers became of supreme importance, and Reynolds's work found its application.

During the six years ending 1880 numerous papers were read by Reynolds at the Institute of Naval Architects, the problems of the steering of ships and the efficiency of the propeller itself being the chief subjects under discussion. The importance of the phenomenon of cavitation, which had been studied by Reynolds in some detail twenty years before, was not generally recognised until, in 1897, the steam turbine was first applied to marine propulsion.

In 1887 a paper on the use of models for determining the *régime* of rivers and estuaries was read by Reynolds at the British Association, and led to the appointment of a committee to pursue the subject. On behalf of this committee Reynolds carried out a series of experiments which were published in three successive reports. The work attracted considerable attention, and a special commission was sent from Paris to obtain his advice with regard to the drainage works then in course of construction in the Seine estuary.

A large number of Reynolds's papers deal with problems in hydraulics. Having devised an ingenious method of delineating the stream lines by the introduction of colouring matter, he proved that there is a critical velocity at which the flow of water in a pipe becomes turbulent, and measured its magnitude. By an application of the principles thereby involved, he was enabled to design the first workable multi-stage turbine pump, of which he must be regarded as the originator; and in the further pursuance of related questions, he was led to the more theoretical and mathematical discussion of vortex motion and lubrication.

In 1889 Reynolds published a set of trials on a 100-h.p. steam engine, which he had specially designed to meet the requirements of his experimental work. These trials are repeatedly quoted in technical publications as standard examples of engine tests.

Later he conceived the idea of employing the same engine for a re-determination of the mechanical equivalent of heat. To absorb and measure the power generated, he used an ingenious form of hydraulic brake, which he had designed some years before. The value given as the result of these experiments is universally accepted.

In looking through Osborne Reynolds's collected works one is struck by the thoroughness and acumen with which he pushed his ideas to their full consequences on the theoretical and physical, as well as the practical and engineering side.

Thus while he was investigating the condensation of steam with a view to its practical explanation, Crookes's beautiful experiments on the radiometer attracted his notice, and he tried to bring the two phenomena into connection. This led him to a first attempt at explaining the radiometer action, which was subsequently abandoned in favour of the now generally accepted view. This investigation caused him to consider the relative efficiency of convection, conduction, and radiation in the transmission of heat, and he obtained results which were applied to engineering problems.

If we turn to his hydrodynamical work, we find that a practical problem—the racing of propeller screws—first led him to this subject, but he was soon drawn to questions of high theoretical interest, such as the transmission of energy in waves with their application to group velocities.

It is difficult at the present time fully to estimate the place which his great work on the "Sub-mechanics of the Universe" will ultimately occupy. His point of view differs in important respects from that which is at present in favour, but he proved right on so many occasions when he struck out a line of his own, that it would not be surprising if at any rate some portion of his work were—perhaps with a different interpretation of symbols—to find its application in the further development of our ideas on the constitution of the fundamental medium.

To those who only knew Osborne Reynolds in his later life, when a difficulty of putting his thoughts into words grew upon him, and finally developed into a fatal illness, the beautiful clearness and precision of his earlier writings may come as a surprise. Together with Roscoe, Balfour Stewart, Gamgee, Stanley Jevons, Ward, and Williamson, he formed one of the band of workers which first made Owens College famous as a centre of teaching and investigation.

He was elected a fellow of the Royal Society in 1877, and received a Royal medal of that Society in 1888, but this and an honorary degree conferred by the University of Glasgow was the only public recognition he ever received.

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society:—Prof. J. O. Arnold, Prof. C. G. Barkla, Mr. L. Cockayne, Mr. A. L. Dixon, Sir T. L. Heath, Dr. H. O. Jones, Prof. T. R. Lyle, Dr. W. McDougall, Mr. R. Messel, Prof. B. Moore, Mr. E. Nettleship, Mr. R. Newstead, Vice-Admiral Sir H. J. Oram, Dr. G. T. Prior, and Mr. R. C. Punnett.

THE King will open the London Museum, Kensington Palace, on March 21. The Queen will accompany his Majesty at the opening ceremony.

THE Berlin correspondent of *The Times* announces the death, at seventy-seven years of age, of Prof. Richard Andrée, of Leipzig, known as a geographer and author of several ethnographic books.

THE General Board of the National Physical Laboratory will hold its annual meeting at the laboratory on Friday, March 15, when the various departments of the laboratory will be open for inspection, and apparatus of particular interest will be on view.

IN the Italian Chamber on February 24 a motion was made and carried to express the sympathy of the Italian nation with the British in the loss of Lord Lister, who was described as one of the most illustrious benefactors of humanity.

AT a representative and influential private meeting on February 27, convened by the Lord Provost of Glasgow, it was unanimously agreed that a memorial of an important character to the late Lord Lister should be erected in Glasgow, the birthplace of aseptic surgery. A committee was appointed to consider various suggestions as to the form which the memorial should take, and to report upon them.

THE annual autumn meeting of the Institute of Metals will be held in London on two days in the last week of September. The next meeting of the institute will be the occasion of the third May lecture, which will be delivered on May 10 by Sir J. A. Ewing, K.C.B., F.R.S., on the subject of "The Inner Structure of Simple Metals."

A SMITHSONIAN expedition, under the direction of Mr. H. C. Raven, will start in a few days for Borneo, where a collection of vertebrates and ethnological material will be made for the United States National Museum. The field work will be carried on in eastern Dutch Borneo, the natural history of which is almost unknown.

REFERRING to a note on the October issue of *Tropical Life*, published in these columns on November 30, 1911 (vol. lxxxviii., p. 154), Dr. H. D. Gibbs informs us that he has written to our contemporary to correct some of the data wrongly attributed to him in the article mentioned. Dr. Gibbs points out that the writer in *Tropical Life* should have said that "750 to 1000 hectares of nipa swamp will operate a 500-ton sugar-mill 180 days each year, not a 100-ton mill continuously."

WE notice with regret the death, on February 21, in his ninety-second year, of Sir John G. N. Alleyne, Bt., known as an authority in engineering and for his interest in iron and steel research, especially the application of the spectroscope to analysis. Sir John Alleyne was, we learn from *The Times*, an original member of the Iron and Steel Institute, and was a vice-president of the institute during recent years. He was also a member of the Institution of Civil Engineers and the Institution of Mechanical Engineers. He was associated with many important railway contracts, including the building of the St. Pancras Station of the Midland Railway, and was responsible for the design of much colliery plant.

SPEAKING in the House of Commons on Monday, February 26, the Minister for Agriculture said it is proposed to place at the disposal of Rothamsted a sum of about 2000*l.* annually to help the extension of new work on special lines of research. Arrangements are being made to send several scientific experts to India to prosecute inquiries relating to foot-and-mouth disease, in connection with the commission recently appointed upon the subject. It is anticipated that the cost of this commission will run into some thousands of pounds.

MR. RUNCIMAN, President of the Board of Agriculture and Fisheries, has appointed a committee to advise the Board on matters relating to the development of forestry. Refer-

ences will be made to the committee from time to time as occasion arises. The committee will be asked, in the first instance:—(1) to consider and advise upon proposals for a forestry survey; (2) to draw up plans for experiments in sylviculture, and to report upon questions relating to the selection and laying out of forestal demonstration areas; (3) to advise as to the provision required for the instruction of woodmen. The committee is constituted as follows:—Sir Stafford Howard, K.C.B. (chairman), Mr. F. D. Williams-Drummond, Sir S. Eardley-Wilmot, K.C.I.E., Mr. R. C. Munro Ferguson, M.P., Lieut.-Colonel D. Prain, C.M.G., C.I.E., F.R.S., Mr. E. R. Pratt (president of the Royal English Arboricultural Society), Sir W. Schlich, K.C.I.E., F.R.S., Prof. Wm. Somerville, and the Hon. Arthur L. Stanley. Mr. R. L. Robinson, of the Board of Agriculture and Fisheries, will act as secretary.

A MEMORANDUM of the Secretary of State for War relating to the Army Estimates for 1912–13, just issued as a Parliamentary Paper, states that after careful consideration by the Committee of Imperial Defence, it has been decided to establish at once a joint Army and Navy School of Aviation at which officers of both services shall be taught to fly, before proceeding to the separate Army and Navy establishments at which they will be exercised in the more specialised requirements of their respective services. A site for the school has been selected on Salisbury Plain, and the purchase of the necessary land will be completed at the beginning of April. Building, to plans which have been already prepared, will be pressed forward rapidly, and it is hoped at a very early date to have accommodation at the school for officers and men, instructors, and mechanics, as well as the necessary sheds for aëroplanes and workshops for their repair and adjustment. Provision has also been made on an extended scale for purchase of aëroplanes and other necessary equipment for the school. The Estimates further provide for continuing the experimental and other work of the Army Aircraft Factory, for further buildings required for airships, for an addition of personnel to Army establishments for aëroplane work, and for a considerable number of aëroplanes as a first instalment of the equipment of the Field Army. The total sum provided for the above services amounts to 322,000*l.*, which includes an Admiralty contribution of 14,000*l.* to the general expenses of the school. The increased provision for aviation services is 177,000*l.*

IN a lecture delivered at University College, on February 20, in connection with the Francis Galton Laboratory for National Eugenics, Dr. M. Greenwood pointed out that public opinion respecting the possibility of influencing the infant death-rate by administrative action had greatly changed during the last 100 years, the prevalent belief being that the great majority of deaths in the first year of life were due to preventable causes. Apart from the supposed ill-effects of the industrial employment of mothers, three factors had been associated in the public mind with the rate of infant mortality, viz. the birth-rate, the prevalence of artificial feeding, and poverty. The general conclusion which the lecturer emphasised was that the effects of administrative reforms upon the infant death-rate were in danger of being exaggerated. Any such exaggeration was calculated to do a great deal of harm, because expectations were raised which could not be realised, and the consequent reaction in the public mind might lead to general indifference towards the subject of sanitary administration.

THE general exhibition of lunar study which the Astronomical Society of Barcelona proposes to hold in the University of that city, under the honorary presidency of the Rector of the University, Baron de Bonet, will be open to the public from May 15 to June 15. This exhibition has for its object the grouping in one harmonious whole of the discoveries relating to our satellite. It will comprise at least the following sections:—A, lunar cartography; B, representations of the moon by drawings and models; C, photographs of the moon; D, lunar physics; E, the study of the tides; F, observatories and instruments; G, apparatus for cosmographic demonstration; H, history and biography; I, lunar astrology. The committee arranging the exhibition will be glad to receive offers of assistance from any interested persons, whether members of the society or not. Already exhibits are being received, and the society is anxious to get into touch with anyone who possesses books, drawings, photographs, sketches, models, &c., of items of lunar interest. The last day for entries is April 15, and the last day for receiving exhibits is May 1. The society offers diplomas to exhibitors and to all who contribute in any way to the success of the exhibition. All correspondence and offers of help, &c., regarding the exhibition should be addressed to Don Salvador Raurich, secretary of the society, Gran Via Diagonal, 462, Barcelona, Spain.

DR. A. H. YOUNG, Emeritus professor of anatomy in the University of Manchester, a former president of the Anatomical Society of Great Britain and Ireland, died at his residence in Didsbury on February 22, of an illness which had incapacitated him for the past three years. Prof. Young exercised a considerable influence upon British anatomy during the last quarter of a century, not only by his own investigations, but even more so by the researches which he inspired his assistants to carry on. Much of his earlier work, such as the memoirs on the anatomy of the elk, the hyæna, and the northern beluga, was done in collaboration with his predecessor, Prof. Morrison Watson; but at the same time he carried out a series of investigations of his own upon the anatomy of Phascolarctos, Viverra, Proteles, and the elephant, devoting especial attention to the musculature of the marsupial hand and forearm. After he succeeded to the chair of anatomy in Manchester he and his assistants became interested in embryology, and they produced a series of morphological memoirs, in which the facts of ontogeny and comparative anatomy were happily blended. Prof. Young himself concentrated his attention mainly upon the problems of the morphology of arteries, his best known work being his strong attack upon the commonly accepted interpretation of the middle sacral or caudal artery as the prolongation of the dorsal aorta.

IN a Reuter telegram from Khartûm which appeared in the Press last week, it was stated that Prof. Garstang had discovered at Meroë evidence that the Roman Empire extended much further south than has hitherto been supposed, even to Meroë (Kabushia) itself, the evidence for this conclusion being the discovery of a Roman temple, &c. In this way, the telegram adds, the presence at Meroë of the Augustus-head discovered last year is explained. We have not as yet the facts of the discovery which have led Prof. Garstang to this conclusion, but until they have been carefully examined it would be rash to accept so revolutionary a statement as certain. Hitherto, though the Roman legions are known to have marched so far south as Gebel Barkal (Napata) in the reign of Augustus in order to punish a Nubian invasion of Egypt, the southernmost Roman permanent post has always been supposed to have been Primis (Ibrîm), and this was only occupied for a short time, the usual "furthest south"

having been Syene (Aswân), or at most Hierasykaminos (Mahárraka), at the southern end of the Dodekaschoinos. No literary authority under the Empire gives the slightest hint of any such thing as a Roman station far south of Napata, and within 150 miles of Khartûm, and until definite evidence comes from Prof. Garstang we must suppose that his Roman temple is no more than a Nubian copy of one, and means no regular Roman station. Had there been such a station at Meroë, Strabo could not have failed to mention it.

THE "Memorandum to Sanitary Authorities on the Subject of Epidemic Poliomyelitis" (infantile paralysis, see NATURE, vol. lxxxvii., p. 494), which was issued by the Local Government Board in December, 1911, has now been followed by the publication of further reports upon the subject (New Series, No. 61). The volume contains a report by Dr. Reece on the prevalence of the disease in Devonshire and Cornwall in 1911; another, by Dr. Farrar, on outbreaks in the Midlands and Dorsetshire in 1910; notes by Dr. Mervyn Gordon on the bacteriology of the disease; and clinical and epidemiological notes by Dr. Hugh Macewan. The number of known cases in the Devon and Cornwall outbreak up to September 16, 1911, was 154, with thirty-four deaths, but probably many mild and abortive cases escaped notice. The report concludes with a grave indictment of some of the public authorities of the districts concerned on account of their reluctance to take the steps necessary to cope with the disease.

WE are glad to welcome a new series of publications by the Museum of the University of Pennsylvania. The series will comprise the publications of the Babylonian section of the museum; and a beginning has already been made by the issue of a monograph on "Babylonian Hymns and Prayers," by the Swedish scholar Dr. David W. Myhrman. It is well known that the University of Pennsylvania possesses a very rich collection of tablets obtained as the result of four expeditions which conducted excavations on the site of the Babylonian city of Nippur between the years 1888 and 1900. The greater number of the texts published in the present volume are from this site; others are from collections purchased in London and Baghdad. The tablets contain religious compositions, the majority of which are written in Sumerian, the language of the early non-Semitic inhabitants of Babylonia. Since they date from the end of the third millennium B.C., they are of very great interest as throwing light upon the development of Babylonian religious ideas in their earlier stages. Dr. Myhrman has expended an immense amount of labour in order to reproduce the original script as closely as possible, working on the principles which have governed earlier publications of the Pennsylvania Museum. But, at any rate in the more crowded texts, we could wish that a more conventional transcript had been adopted; this would undoubtedly save time in publication, and would be a real help to the reader. The excellent photographic plates already furnish the student with the necessary epigraphical data. But, apart from this suggestion, we have only praise for the volume before us, which makes the texts available for students on the plan already employed by the great museums of London, Paris, and Berlin. We note with pleasure that the new series largely owes its success on the material side to the generosity of Mr. Eckley Brinton Coxe, jun., who has already done so much to further the scientific aims and interests of the University of Pennsylvania.

AN account of the vertical migrations of *Mysis mixta* in the Baltic is given by A. Otterström in *Meddelelser fra Kommissionen for Havundersögelser*, Plankton, Bd. i., No. 9. The observations deal only with the summer months June, July, and August. During the daytime the Mysis are found only on the bottom. Between 8 and 10 p.m. they move upwards into the higher water layers, the height to which they rise apparently varying with the intensity of the light. The author considers that the whole phenomenon is controlled by light-intensity, and that temperature has little, if anything, to do with it. As *M. mixta* is an important food of the herring in the Baltic, the question is one of some practical interest.

TWO papers recently published by Danish investigators (Danish hydrographical investigations at the Faroe Islands in the spring of 1910, by Martin Knudsen, in *Meddelelser fra Kommissionen for Havundersögelser*, Hydrografi ii., No. 1, and The plankton on a submarine bank, by Ove Paulsen, in *Biologiske Arbeider Tilegnede Eug. Warming*, November, 1911), throw new light upon an oceanographical problem of very considerable interest, namely, the physical and biological conditions upon an isolated bank surrounded by deep water in mid-ocean. The Faroe Bank, which the two authors deal with, lies in the Atlantic at a considerable distance to the S.W. of the Faroe Islands. The temperature of the water on the bank is lower than that of the surrounding ocean water at similar depths, and at the same time the salinity is less. The water on the bank agrees in these features with water from lower depths in the surrounding ocean, and Dr. Knudsen is probably correct in his view that the bank is covered by water which has run up along the slope of the bank from the deep water surrounding it. The plankton on the bank itself is shown to be markedly different, at all seasons at which samples were taken, from that found in the immediate neighbourhood off the bank, the bank plankton having a distinctly neritic, or shallow water, character.

WE learn from *The Journal of Agriculture of South Australia* that an anonymous donor has presented a sum of money to the University of Adelaide for the purpose of providing scholarships for post-graduate work. These are to be called the Lowrie scholarships, in recognition of the services rendered by Mr. William Lowrie, the director of agriculture for the colony. It is proposed that the scholarships be tenable for one year.

WE have received a copy of *La Vie Agricole*, a new weekly agricultural paper issued by J. B. Baillière et Fils, Paris, proposing to deal with scientific and practical matters of agricultural interest. Prof. Perrier gives an interesting summary of the problem of sex determination, whilst M. Diffloth writes an informing article on the desiccation of potatoes in Germany. Summaries are also given of investigations carried out in other countries. Altogether, the new journal promises to form a very useful addition to agricultural literature.

IT appears from *The Journal of Agriculture of South Australia* that the policy of repurchasing estates for closer settlement in South Australia continues to justify itself by the results. Large estates are bought by the Government and subdivided into small holdings of about 300 acres. In one case, where formerly not more than 400 persons inhabited a large area, the population rose under the new system to more than 4500. The value of the improvements effected is invariably high. A very great change in the agriculture of the country is certain to set in, with results that must be wholly beneficial.

AFTER exhaustive experiments with practically all improved artificial pasture grasses, extending over a period of some eight years, the Department of Agriculture in Natal has, we learn from *The Agricultural Journal of the*

Union of South Africa, been compelled to the opinion that *Paspalum dilatatum* and *Phalaris commutata* are the only types which promise to hold their own for more than two years in the veldt conditions obtaining in the midlands of Natal against the competition of native grasses and the weeds of cultivated ground. Paspalum flourishes on very poor soil, and proved excellent for stock. Phalaris is more resistant to frost, but less tolerant of drought and soil poverty. Favourable reports on these grasses are also received from the Transvaal.

RECENT numbers of the Circular and Agricultural Journal of the Royal Botanic Gardens, Ceylon, deal largely with experiments on the tapping of Hevea rubber, by Messrs. Lock, Bamber, and Holmes. A remarkable pest is also described by Mr. Green. The rubber slug, *Mariaella Dussumieri*, Gray, frequents recently tapped Hevea trees and imbibes the latex oozing from the cuts, thus causing an appreciable diminution of the scrap rubber that could be collected after tapping. It seemed barely credible at the time that any animal could digest liquid rubber, but direct experiment showed that when some of the living slugs were provided with a saucer of rubber-milk they at once began to lap it up. The slugs, further, do serious injury to young plants. The only remedial measures at present suggested are traps and the destruction of all rubbish.

A PAPER has been published in the Journal of the Asiatic Society of Bengal, by Mr. B. Hooper, on phosphorus in Indian foodstuffs. The author begins by accepting the well-known conclusions of certain medical investigators that the lack of phosphorus in cleaned or milled rice is the predisposing cause of beri-beri. By experimenting on fowls with rice of varying quality, it was demonstrated that polyneuritis (similar to the human disease) was developed when milled, but not husked, rice was used. Rice containing only 0·277 per cent. of phosphoric anhydride brought on the disease in a few weeks, while rice containing 0·469 per cent. formed a healthy diet. A number of analyses have therefore been made of rice samples from various parts of India. On an average, unmilled rice contained 0·65 per cent. of phosphoric anhydride, and milled rice 0·38 per cent. The pulses contained more, and it is significant that the pulse-eaters generally remained free from the disease, whilst their neighbours, the rice-eaters, were attacked.

NOT long ago the Secretary of State for the Colonies announced that it had been decided in principle to maintain the central establishment of the Imperial Department of Agriculture for the West Indies for a further period of ten years. The opportunity has therefore been taken in No. 4 of the West Indian Bulletin to review broadly the work of the Department in the past, and to indicate some of the problems for the future. There are undoubted signs that the West Indies are recovering from the distress in which they have been plunged during the latter part of the nineteenth century. Confidence in the sugar industry has revived as the result of the abolition of bounties and improved trade relations with Canada; the production of cacao in Trinidad, Grenada, and Jamaica has increased; a considerable American fruit trade has grown up in Jamaica; Sea Island cotton has been introduced into St. Vincent, Barbadoes, and the Leeward Islands; limes have been much grown in Dominica, and rice in British Guiana. But if the conditions are favourable for crops they are equally favourable for pests, and perhaps nowhere is more careful and continuous work necessary on the part of mycologists and entomologists. There is also much scope for the work of the plant-breeder, for it has been shown that some of the new seedling canes are very much more profitable than the older ones.

THE current issue of the Journal of the Quekett Microscopical Club (November, 1911) contains interesting observations, by Mr. D. J. Scourfield, on the use of the centrifuge in pond-life work. He finds that a high speed (7000–10,000 revolutions per minute) is necessary to bring about the concentration of some of the more minute organisms; when so high a speed is required, centrifuge tubes holding only about 1·5 c.c. are used. This method is to be regarded as accessory to the ordinary methods of collection by means of nets and filters. Mr. C. D. Soar gives a list of fifty species of Hydrachnids (water-mites) collected, for the most part near London, by the late Mr. Saville-Kent, whose account of the anatomy of these animals is also published. Mr. E. M. Nelson contributes some hints on methods of illumination in microscopic work, and lays great stress on the importance of centring the beam of light entering the objective, in order to obtain good definition. Whether the beam is centred properly is most readily ascertained by examining, either with the unaided eye or with a hand-lens, the "Ramsden disc," the centre of which should be illuminated. Mr. Nelson adds some notes on the use of colour-screens. Dr. E. Penard gives an account of fourteen species (three of which are new) of fresh-water Rhizopods from Sierra Leone, and Mr. T. A. O'Donoghue records the finding of dimorphic spermatozoa in the human flea and in the blow-fly.

WHILE the geology of Newfoundland has been investigated to some extent, its physiography has hardly been touched upon from the modern point of view. In the January number of *The American Journal of Science* Mr. W. H. Twenhofel contributes a very instructive description of the island from his observations made during a study of the geological structure of the western and north-western coasts. The topography is strongly impressed by the structure, of which the north-easterly trend finds expression in parallel ridges and valleys having the same direction as the folds and faults, softer strata and zones of weakness having been eroded. The upland surface presents the dissected remains of a former peneplain, which once extended over the whole of Newfoundland, and which it is suggested may have been completed before Cretaceous time, like that of the Appalachian region. Elevated valleys occur at altitudes of 800 to 1200 feet, and may probably be attributed to erosion at a period when the land stood lower by about this amount than at present. This cycle of erosion was not completed, but was interrupted by renewed uplift of the Long Range in pre-glacial times, since the evidence tends to show that this range owes its origin to the faulting upward of a block from the foreland's level.

THE Survey Department of Egypt has commenced the publication of Bulletins dealing with the astronomical and geophysical work carried out at the Khedivial Observatory at Helwan. No. 1, by Mr. E. B. H. Wade, deals with the local attraction of the plumb-line in the prime vertical near the Nile Valley, which has been observed during the work on the geodetic survey of Egypt which is in progress. It had been anticipated that so much as 2″ might be met with, but when the triangulation had been carried about 150 kilometres south of Cairo the values obtained for a pair of azimuths taken to and fro across the valley were found to be discordant to the extent of 11·9″. After the careful elimination of instrumental errors, a direct determination of the difference of longitude between the observa-

tory on the east and a base terminal point on the west of the valley by a method especially suitable to the case, and the reobservation of the azimuth of the southern side, the conclusion is reached that in this part of the Nile Valley the local attraction in the prime vertical is 8·8″ and 6·9″ by different methods on the northern side, and 12·6″ on the more southern side, the plumb-bob being repelled from the axis of the Nile Valley. The method employed is described.

WE have received the fourth and concluding part of the first volume of the Bulletin of the Seismological Society of America. The papers which it contains are mostly brief. Among the more interesting may be mentioned a biographical notice with an excellent portrait of Major C. E. Dutton, described, in forgetfulness of Prof. C. G. Rockwood, as America's first seismologist. Mr. Otto Klotz gives a simple method of locating the epicentre of an earthquake from the duration of the first series of tremors at three widely separated stations. Mr. E. C. Templeton describes a rather strong earthquake on July 1, 1911, in Central California. From the nature of the shock and the disposition of the isoseismal lines it is evident that the earthquake was a twin, the more important of the two foci being situated near Coyote, a village twelve miles south-east of San Juan. The paper of greatest value is one by Prof. A. C. Lawson on a remarkable series of small post-Glacial fault scarps near Banning, in western Ontario. They have been exposed by the removal of the glacial drift, which until recently has helped to preserve the sharpness of the scarps. The glaciated rock so far uncovered is about a quarter of an acre in area, and is dislocated by a large number of small reversed, or overthrust, faults. Along a transverse line 66 feet in length twenty-four scarps were counted, the height of which ranges from an eighth of an inch to 3¾ inches. The movement of the faults, as shown by the displacement of the glacial striæ, was invariably in the direction of the dip.

THE Journal of the Franklin Institute for January contains a noteworthy paper, recently read by Prof. Cleveland Abbe, entitled "The Obstacles to the Progress of Meteorology." To form an adequate idea of the important questions dealt with it would be necessary carefully to peruse the paper. Prof. Abbe states at the outset that he is not a pessimist. He says:—"We have been so long accustomed to fairly accurate and very useful daily weather forecasts that we begin to look for perfection in long-range predictions. Let us be optimistic and believe that eventually these will come." But he asks why it is that that progress has been so slow, and why we have been unable definitely to establish the existence of periods in our local climates. Possibly they do not exist, but if they do they are completely covered up by the defects of observations. He gives a number of illustrations showing that observations have been at fault because instruments have been faulty, exposures changed by growth or disappearance of trees, and various other causes. Although balloon observations now record what is going on ten or fifteen miles above us, and although daily weather maps have been published for the whole of the northern hemisphere, the great obstacle that hinders perfect prediction is our ignorance of many details as to the laws that govern the atmosphere. The author considers that the existence of laboratories specially adapted to atmospheric experiments is of fundamental importance, and the association therewith of able students trained in mathematics and physics. "When all this is realised, the intellectual work that will there be done will gradually remove all obstacles to the eventual perfection of our knowledge of the atmosphere." But, as in the case of astronomical observatories and all other scientific institutes, plans must be made for many years of labour.

SINCE the introduction of the earth inductor as an instrument for the determination of the magnetic dip, the question is often asked, Does the earth inductor or the dip circle give the more accurate results? The editor of *Terrestrial Magnetism and Atmospheric Electricity* gives the results of his experience in a note in the December (1911) number. The earth inductor, once set up, gives a result in fifteen minutes five times as accurate as the dip circle will give in an hour. While dip circles differ amongst themselves by a few minutes, inductors agree to within a few tenths of a minute of arc. For survey work, when the instrument has to be set up afresh at each place of observation, the present type of inductor has no advantage over the dip circle, but it is hoped that ere long an inductor suitable for such work will be constructed.

THE first number of the Science Reports of the Tôhoku Imperial University, Sendai, Japan, contains an important paper by Prof. Honda on the thermo-magnetic properties of forty-three chemical elements, most of which were obtained in a state of great purity. The magnetic susceptibilities of these elements up to temperatures in many cases exceeding 1000° C. were measured by the pull exerted on them by the non-uniform magnetic field between the pointed poles of a Du Bois electromagnet. The strength of the field could be increased to 23 kilogauss, and was determined by the aid of a small coil and a ballistic galvanometer. The pull was measured by means of a torsion balance. With the exception of iron, nickel, and cobalt, these elements have susceptibilities which are independent of the intensity of the magnetic field. Some of them change their susceptibility with change from solid to liquid or from one crystalline form to another. The susceptibility appears to be connected intimately with the position of the element in the periodic system of chemical classification. The laws stated by Curie, *i.e.* for diamagnetic substances, susceptibility generally independent of temperature, and for paramagnetic inversely proportional to the absolute temperature, were found not to be correct, and Prof. Honda substitutes the law: increase of temperature produces a change of susceptibility towards that of the element of next higher atomic weight.

SOME interesting conclusions concerning the spectra produced in gases and vapours by different types of electric discharge are recorded by M. G. Millochau in a paper which is published in No. 18, vol. cliii., of the *Comptes rendus*. By projecting an image of the spark on to a slit, an image of which was in turn projected on to a photographic film revolving at a known rate, the author obtained photographic evidence as to the nature and duration of the discharge. At the same time he photographed the spectrum produced in various gases, enclosed in Plücker tubes, by the different discharges, and so was able to correlate the different spectra with the respective types of discharge producing them. By this means he differentiates seven types of "simple" discharges, each of which always produces the same spectrum, whatever may be the pressure in the tube, and finds that in a complex discharge the resulting spectrum is the summation of the spectra produced by the several superposed "simple" discharges; the simple discharges range from a continuous discharge obtained, for example, by joining up the terminals of the secondary of a Ruhmkorff coil, without condenser, directly to the terminals of the vacuum tube, to an intermittent discharge from a condenser through a considerable resistance. The "simple discharges" may be grouped under three general heads:—(1) the slow dis-

charge, (2) the "semi-brusque" discharge, and (3) the "brusque" discharge, of which the respective durations are of the order of 0·01 sec., 0·0001 sec., and 0·00001 sec., and M. Millochau briefly describes the different types of spectra produced in various gases by each. Thus in CO_2 the first produces the "Swan" spectrum, while the second produces the spectrum of carbonic oxide in place of the "Swan." With the "brusque" discharge, "line" spectra are produced, the lines of hydrogen and helium being always broad. Finally, M. Millochau arrives at the most important conclusion that his results favour the dissociation hypothesis, inasmuch as they appear to show that the production of the various spectra depend upon the temperature of the vibrating molecule and upon the dissociation effects which correspond to this temperature.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR MARCH:—

March 2. 2h. 0m. Mercury in superior conjunction with the Sun.
4. 5h. 0m. Mars at quadrature to the Sun.
4. 16h. 0m. Jupiter at quadrature to the Sun.
9. 22h. 36m. Jupiter in conjunction with the Moon (Jupiter 4° 59′ N.).
13. 19h. 12m. Uranus in conjunction with the Moon (Uranus 4° 43′ N.).
15. 19h. 6m. Venus in conjunction with the Moon (Venus 3° 43′ N.).
19. 16h. 44m. Mercury in conjunction with the Moon (Mercury 1° 47′ N.).
20. 11h. 30m. Sun enters Sign of Aries; Spring Equinox.
22. 6h. 14m. Saturn in conjunction with the Moon (Saturn 1° 36′ N.).
24. 20h. 30m. Mars in conjunction with the Moon (Mars 2° 44′ S.).
26. 16h. 19m. Neptune in conjunction with the Moon (Neptune 5° 53′ S.).
27. 14h. 0m. Mercury at greatest elongation east of the Sun. (18° 51′ E.).
31. 17h. 0m. Venus in aphelion.

THE ECLIPSE OF THE SUN ON APRIL 17.—In a memoir prepared by the Madrid Observatory there is an excellent account of the conditions for the total and annular eclipse which will be visible in the peninsula on April 17 next. Intended for popular information, the memoir contains not only the data calculated for the eclipse in general and for several favourable localities, but also gives an account of the geometry of eclipses, the methods of calculation, the results, and some excellent diagrams and maps showing the track of the shadow.

As an example of the application of the method of calculating the values for any particular place, Cacabelos (long. = 6° 42′ 57″ W. of Greenwich; lat. = 42° 35′ 53″ N.) is selected, and for this place it is found that totality will last 4·6 seconds, the middle of the eclipse occurring at 23h. 48m. 54·7s. Other places where the eclipse will be total were selected, and, in order to ensure accuracy, a commission was appointed to determine their geographical coordinates. They are Barco de Valdeorras and Verin, and their positions were found to be:—long. 3° 17′ 43·5″ W. of Madrid, lat. 42° 25′ 5·4″ N., and long. 3° 45′ 12·0″ W. of Madrid, lat. 41° 56′ 29·0″ N., respectively. The track of the eclipse across the peninsula is shown on a large-scale map (1 : 500,000) at the end of the memoir, the central line passing from immediately north of Ovar, in Portugal, to Oviedo, and leaving the northern coast slightly to the east of Gijon.

THE EARLY BABYLONIAN ECLIPSE OF THE SUN.—In a paper appearing in part iii., vol. ii., of the Transactions of the Royal Society of South Africa, Mr. Nevill discusses at length the vexed question of the date to be assigned to the eclipse of the sun recorded on Tablet No. 35968 of the British Museum collection, which Dr. Cowell has identified with the eclipse of −1062, July 31. He describes the broken tablet, and discusses Mr. King's reading of the same from several aspects, arriving at the conclusion that the internal evidence does not preclude a date in the twelfth century B.C., or even earlier. After examining every eclipse occurring between 1250 and 920 B.C., Mr. Nevill, by several processes of elimination, finds that, without assuming any secular acceleration of the sun's motion, the eclipses which fit the various conditions, of time, date, place, &c., best are those of June 5, 1217, May 18, 1123, and May 31, 956 B.C., and of these three the first most closely corresponds with theory and observation.

Finally, he points out that Dr. Cowell's hypothesis of secular acceleration, permitting a number of ancient eclipses to be recognised, constitutes a strong case if no other hypothesis can be found, but its adoption raises several questions which for the present cannot be satisfactorily answered.

THE PROPER MOTIONS OF THE STARS IN THE CLUSTERS *h* AND χ PERSEI.—Vol. v. of the *Recherches Astronomiques de l'Observatoire d'Utrecht* is devoted to a thesis prepared by M. A. van Maanen dealing with an investigation of the proper motions of 1418 stars in and near the famous double cluster *h* and χ Persei.

The object of the investigation was twofold: first, to find the proper motion of the two clusters; secondly, to determine the frequency of the proper motion according to its amount and to the magnitudes of the stars for this region of the sky. From a number of plates six were selected, two pairs taken by Kostinsky in 1896 and 1908, and one pair by Donner in 1892 and 1909, and among the conclusions arrived at it is maintained that this method of using pairs of plates is not inferior to that where the images are impressed upon the same plate at different epochs. The proper motions resulting from the discussion are so small as to render it impossible to make out which stars are, and which are not, members of the groups. In determining the frequency of the proper motions, it was found that, of the 763 stars considered, 300 had P.M.'s between 0·010″ and 0·019″, while only 142 had motions less than 0·010″; no sufficient reason has yet been found for the relatively small number of small proper motions.

THE TERRESTRIAL MAGNETIC EFFECTS OF SOLAR RADIATION.—In an extract from *Ciel et Terre* (No. 12, 1911) Dr. A. Brester discusses the causes which produce the diurnal oscillation of the magnetic needle and other terrestrial magnetism effects. In the place of the vortices produced by the heating effects of the solar radiation, he would substitute vortices produced by solar kathode rays, and he shows how the action of these would be concentrated in the neighbourhood of the earth's poles where the greatest oscillations of the needle are recorded. Further, he points out that electrical tourbillons would not be disturbed by ordinary atmospheric disturbances, and thus would give regular changes such as are observed, and also that, the electrical state of the sun depending on the solar activity, his theory would account for the observed relation between the diurnal oscillations of the needle and the number of sun-spots.

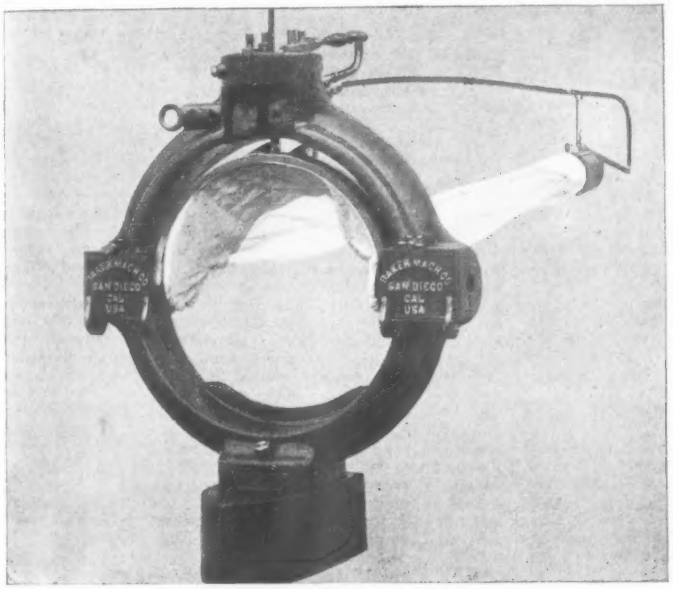
ABSORPTION OF LIGHT IN SPACE.—The January number of the Monthly Notices contains an interesting paper by Mr. F. G. Brown, in which the author discusses the absorption of light in interstellar space. Taking all the nebulæ given in the N.G.C., he found approximate measures of the intrinsic brightness of each by comparing the total brightness, or conspicuousness, as given in the N.G.C. with the diameter. Although this method of dealing with the subject cannot be regarded as final, the results are very striking, and indicate that the small nebulæ appear less bright per unit area than do the large nebulæ, or, in other words, the probably distant are fainter than the probably near. Mr. Brown's preliminary investigation also suggests that the absorption is different in different directions through space.

AN OBSERVER'S HANDBOOK.—"The Observer's Handbook for 1912," published by the Royal Astronomical Society of Canada, is a valuable compendium of the data likely to be required by the isolated amateur. It contains various ephemerides and tables, useful star-charts, notes on the constellations and phenomena for each month, tables showing the times of sunrise and sunset for each day in latitudes 44°–52°, and brief accounts of the eight comets of 1911. The handbook contains sixty-four pages, and is sold for 25 cents at the society's rooms, 198 College Street, Toronto.

A SELF-CLOSING PLANKTON NET FOR HORIZONTAL TOWING.

A SELF-CLOSING plankton net has long been needed for horizontal towing. It is especially necessary for the investigation of the vertical distribution of pelagic organisms. Numerous attempts have therefore been made, from the time of Pavesi (1883) onward, to devise a satisfactory instrument for this purpose. The latest, and apparently the most satisfactory one of its kind, has been designed by Prof. Kofoid after suggestions from Dr. G. H. Fowler, of the *Research* expedition.

The net is a ring net with circular opening, which can be both opened and closed under water by messengers. The bag of the net is, as usual, of silk bolting cloth, a simple cone held horizontally by a support. The frame is a heavy casting of phosphor bronze, with enlargements at the horizontal axis for the reception of the hubs of the jaws of the net. The upper end of the frame is expanded to form a head-piece enclosing and protecting the tripping mechanism for the net jaws, and the lower edge bears a slot for attaching the heavy weights.



A Self-closing Plankton net.

The net is balanced in a vertical position by the very heavy lower flatiron-shaped weight.

The mouth of the net is formed not by one continuous ring, but by two hinged jaws, which can both be brought up and held together by the tripping apparatus. In the figure both jaws are in this position, and the net mouth is closed, the net being ready for descending. The two semicircular jaws can rest in three positions: they may be both folded against each other and held upwards as in the figure, or one may be allowed to fall forwards and downwards until both jaws complete a circle and the net mouth is open. In the third position both jaws lie against each other, but hang downwards.

There are two "trips," one of which is operated by the first messenger, the other by the second.

The net is lowered vertically, the ship being at rest, to the desired depth, and the first messenger sent down the cable. This releases the lower jaw, which falls forwards and downwards until the net mouth is open.

After towing is completed and the cable is perpendicular, the second messenger is sent down, and the upper jaw is released. It falls to the lower position, is held firmly against the lower jaw, and thus the net is closed.

The advantages which this net possesses over other models are stated by Kofoid to be:—

(1) A method of opening and closing at any level in the sea under complete control of the operator.

(2) Perfect and continuous closure of the net during descent and ascent.

(3) Possibility of horizontal towing.

(4) An opening free from interfering structures which tend to ward off more active pelagic animals.

W. J. D.

THE ANTHROPOLOGICAL SURVEY OF CANADA.

THE Dominion of Canada is the first of our colonies to have an official department for the sole purpose of anthropological investigation, and it is to be hoped that this good example will be followed speedily elsewhere. The history of this new departure is briefly as follows.

When the British Association met at Montreal in 1884, a committee, consisting of Dr. E. B. Tylor, Dr. G. M. Dawson, General Sir J. H. Lefroy, Dr. Daniel Wilson, Mr. Horatio Hale, and others (the personnel of which was subsequently modified), was appointed for the purpose of investigating and publishing reports on the physical characters, language, industrial and social condition of the north-western tribes of the Dominion of Canada. The twelfth and final report of the committee was presented at the Bristol meeting in 1898, which, in addition to original articles, contained a summary of the work of the committee in British Columbia by Dr. F. Boas, and an index to reports iv.–xii. In view of the meeting of the association in Toronto in 1897, a new committee, consisting of several Canadian and British members, was appointed at the Liverpool meeting in 1896 "to organise an ethnological survey of Canada," of which Dr. George M. Dawson was chairman and secretary. Prof. D. P. Penhallow was elected chairman in 1899. The committee suffered a great loss by the death of Dr. Dawson in 1901; he was succeeded by Mr. C. Hill-Tout. Prof. J. L. Myres, in his presidential address to Section H at Winnipeg, gave a short history of the work of the two committees, and stated that "the premature death of George Dawson in 1901 broke the mainspring of the machine; the field-workers fell out of touch with one another and with the subject; the instruments were scattered, and in 1904 the Ethnographic Survey Committee was not recommended for renewal." Thanks mainly to the energy of Prof. J. L. Myres and Mr. E. S. Hartland, a third committee was appointed at Winnipeg, 1909, with the Rev. Dr. G. Bryce as chairman and Mr. Hartland as secretary. The Ethnographic Survey Committee reported at the Sheffield meeting in 1910 (Report, p. 265) that its work had been crowned with success. The recommendations of this committee at the Winnipeg meeting to the Dominion Government were supported by delegations of the Canadian section of the Archæological Institute of America and the Royal Society of Canada, and on September 1, 1910, a division of anthropology under the Geological Survey of Canada was established, of which Dr. E. Sapir was made director. Dr. Sapir is a distinguished student trained by Prof. F. Boas. Dr. Boas is himself intimately acquainted with Canadian ethnology, and in 1888, under the auspices of the committee of the British Association, began his field-work among the north-west tribes which has led to such brilliant results. The inauguration of the new department could not have been put in better hands, but the work was clearly too vast for one man to cover it. On January 1, 1911, Mr. C. M. Barbeau, a very promising Canadian

who had been trained at Oxford, was appointed assistant in anthropology, and on June 15 Mr. Harlan I. Smith, formerly of the American Museum of Natural History, New York, entered on his duties as archæologist. Mr. Smith is well known as a keen and conscientious archæologist who has done some good work in British Columbia and elsewhere. The Canadian Government deserves hearty commendation for its appreciation of the need of an anthropological survey of Canada, and of the excellent selection of a staff with which to carry it out. May we be permitted to hope that at no distant date the services of a physical anthropologist will be secured?

It is true that a certain amount of work has already been done in Canada; but it has been of a sporadic character, and without any system, except that done by the Jesup North Pacific Expedition; attention should, however, be directed to the series of papers on the Salish tribes published by Mr. Hill-Tout, mainly due to the action of the British Association Committee, and to the fine monograph on "The Great Dené Race," by Father A. G. Morice, in *Anthropos*, vols. i., ii., iv., v. Dr. Sapir is fully aware of this; and while investigations of limited areas and peoples must first engage the attention of the small staff, he has already mapped out the problems which have to be solved, and thus the detailed work will fill gaps in a well-thought-out scheme. The best general account we have of Canadian ethnology is the valuable Archæological Report, 1905, printed by order of the Legislative Assembly, Toronto, 1906.

In a report published in *Science*, December 8, 1911, Dr. Sapir says:—"The ethnological work already undertaken by the division embraces three distinct lines of inquiry. The first of these was undertaken by [himself] among the Nootka, and resulted in the amassing of much material of linguistic and ethnological interest. It is intended to carry forward this work from year to year. The second line of inquiry is the analysis of the culture of the Iroquois, including under this term the Huron-Wyandots, who were never included in the league. This work was undertaken by Mr. Barbeau, who, beginning with the Hurons of Lorette and the few Wyandots still left in western Ontario, took up an intensive study of the most conservative group of Wyandots, those of Oklahoma. The study of the Iroquois proper, particularly from the point of view of social organisation, was entrusted to Dr. A. A. Goldenweiser, of Columbia University, who has amassed much of value at Grand River Reserve. The third point of attack was the culture of the eastern Algonkin tribes. Here a beginning was made by Dr. Cyrus MacMillan, of McGill, among the Micmac, and by Mr. W. H. Mechling among the Malecite. It is hoped to begin systematic work among the Cree, Ojibwa, Plains tribes, and tribes of the Plateau-Mackenzie region as soon as opportunity will permit. So far, the archæological work of the division has been confined to a preliminary reconnaissance, by Mr. Smith, of the field in eastern Canada. Hand-in-hand with research and publication, which must naturally form the main activity of an anthropological survey of Canada, is the building up of an anthropological section of the national museum at Ottawa. At present the museum is relatively rich in West Coast ethnological and Ontario archæological material, to the neglect of other fields. Persistent efforts are now being made to round out the resources of the museum.

"The Canadian Government is to be congratulated on having established a systematic survey of aboriginal Canada. Now or never is the time in which to collect from the natives what is still available for study. In some cases a tribe has already practically given up its aboriginal culture, and what can be obtained is merely that which the older men still remember or care to impart. With the increasing material prosperity and industrial development of Canada, the demoralisation or civilisation of the Indians will be going on at an ever-increasing rate. No short-sighted policy of economy should be allowed to interfere with the thorough and rapid prosecution of the anthropological problems of the Dominion. What is lost now will never be recovered again."

This is a very good example of the way in which the overseas meetings of the British Association justify themselves.

A. C. HADDON.

SOOT.[1]

THE smoke nuisance, like certain other public abuses, is rapidly approaching the acute phase which seems necessary before the patient town dweller changes his tone from an inarticulate murmur to a muttered complaint sufficiently loud to awaken the slumbering authority to a sense of his duty.

The smoke abatement societies serve as his mouthpiece; they have been formed to collect information, hold conferences, organise exhibitions of smoke-preventing appliances, and generally to create discontent with the present whilst encouraging hope for the future.

These societies have recently banded themselves together into a Smoke Abatement League, one of the objects of which is to persuade the Local Government Board to modify the present method of dealing with smoky chimneys. If statistics furnish any guide for public action, the League has fully justified its aims. Within the last few months facts have been forthcoming from different and quite independent sources showing not only the nature of soot and its effects, but the actual amounts discharged into the air and falling to the ground in the course of the year. These quantities are not reckoned in cwts., but in hundreds and thousands of tons.

Messrs. Cohen and Ruston have shown that the quantity per square mile which falls in Leeds increases from 25 tons on the outskirts to 539 tons in the industrial centre of the town. In London, Messrs. Des Vœux and Owens have found the quantity to vary from 58 tons at Sutton, in Surrey, to 426 tons in Old Street, E.C., and Mr. Fyfe, of Glasgow, in a paper read at the Manchester Smoke Abatement Conference, has found that whereas 72 tons falls at the seaside village of Bo'ness, the amount in Glasgow reaches about 820 tons per square mile. The three large towns together show a total deposit of nearly 50,000 tons of soot a year, or about 18 lb. per head of the population (6¼ millions). At the same rate the yearly soot-fall for the whole of the United Kingdom would reach about 300,000 tons; but this number is probably too high, as it includes country districts where naturally the quantity per head is much smaller. The method for estimating the deposit which has been used in Leeds was to collect rain water at eleven different stations (ten in the town and one in the country) by means of a large funnel placed in the neck of a Winchester quart bottle, and to analyse the contents monthly during a whole year. These estimations included the soot (in which the content of carbon, tar, and ash was determined) and the soluble constituents, viz. free and albuminoid ammonia and nitrates, free and combined sulphuric acid, sulphurous acid and chlorine. In Glasgow the deposit was estimated by means of eighty-three dust boxes, sixteen being distributed about Glasgow and the remainder placed in other districts. They were left for two months (December, 1910, and January, 1911), and the contents were then weighed and analysed for carbon, tar, and ash. Messrs. des Vœux and Owens have used a similar method to that adopted in Leeds, but on a much larger scale, substituting for the funnel a large hopper connected with a capacious bottle. The contents were treated as in Leeds, both insoluble and soluble constituents being estimated. The experiments were also continued throughout the year. There does not seem to be any great advantage gained by the substitution of the larger and more costly apparatus for the funnel and Winchester quart bottle if the analyses are carried out with sufficient care.

In addition to the monthly sootfall, the Leeds experiments have included the estimation of the total soot discharged from domestic and factory chimneys, and the still more important permanent deposit of tar, which is the prime agent in the discoloration of buildings and foliage, and (on account of its acid character) in the destruction of masonry, mortar, fabrics, and vegetation. The quantity of soot produced in Leeds annually from factory and domestic chimneys is roughly 35,000 tons, which is distributed as follows:—

1 "Soot: its Character and Composition." By Cohen and Ruston. (Journ. Soc. Chem. Ind., December 15, 1911.)
"Air Pollution in Glasgow and Other Towns in Scotland." By Peter Fyfe. Paper read at the Manchester Smoke Abatement Conference, November, 1911.
"The Sootfall of London." (*The Lancet*, January 6, 1912.)

	Tons.
Blown away	31,480
Temporary deposit in the town	3,472
Permanent deposit in the town	48
	35,000

The method of determining the permanent deposit was by means of glass plates a foot square, which were exposed at different stations for three months at a time. The surface was then rinsed with water to remove any loose material, and the deposit removed and analysed. As this tarry material is much the most deleterious ingredient of the soot, the method of comparing the translucency of these plates after exposure with certain standards may be recommended as a rough test of atmospheric pollution by smoke.

Cohen and Ruston have calculated that in a domestic fireplace about 6 per cent. of the fuel escapes as soot, whereas in a boiler or other furnace the loss may be reckoned at $\frac{1}{2}$ to $\frac{3}{4}$ per cent. Taking the estimated coal consumption from both sources, we get for the whole country a loss in the form of soot of :—

	Tons
6 per cent. on the estimated domestic consumption of 32 million tons ...	1,920,000
0·5 per cent. on the estimated factory consumption of 100 million tons ...	500,000
	2,420,000

From the ratio of soot emitted to soot deposited in Leeds, the above 2,420,000 tons will yield a deposit of nearly 300,000 tons in the neighbourhood where the coal is consumed; for it must be remembered that the whole quantity will sooner or later reach the earth.

Comment is unnecessary. On the ground of the discomfort, dirt, waste, and pecuniary loss which smoke entails, the evil is one which should receive serious consideration, and it is to be hoped that the forthcoming conference and exhibition which is being promoted by the London Coal Smoke Abatement Society will be successful in directing more attention on the part of the authorities to the disastrous effects of smoky chimneys.

J. B. C.

BELGIAN BOTANICAL INVESTIGATIONS.[1]

THE supplementary part of the seventh volume is entirely occupied with a sketch of the geographical botany of Belgium by Dr. J. Massart, providing a continuation of the more specialised account of the vegetation of the littoral and alluvial districts by the same author published in the original volume, and previously noted in NATURE. The sketch does not contain any such detailed observations as are recorded in the botanical surveys carried out in Great Britain by W. G. Smith, C. E. Moss, and others, but incorporates the results of various Belgian researches, notably the modification of leaves in dry and moist localities furnished by Miss M. Ernould, the periodic phenomena of vegetation carefully studied by the meteorologist, Dr. E. Vanderlinden, in connection with climatic variations, as well as several geological and agricultural investigations. Geology occupies a more prominent position than is usual in an œcological botanical memoir, and practically supplies the basis of treatment in the most important chapter. The classification of associations is artificial. Uncultivated and cultivated areas are placed in antithesis. As might be expected in a country where mountain ranges are wanting and intense cultivation is general, there are few natural associations; apart from the dunes, the most important are the types of vegetation growing on cliffs and rocks.

A notice of Dr. Massart's able contribution would be quite incomplete without an expression of cordial admiration of the excellent photographs and maps that are collected in the "Annexe." Of the photographs, more than half are stereoscopic, and to ensure that they shall be fully appreciated a simple but effective stereoscope is provided. It will be observed that the author has paid particular attention to the photography of cryptogamic plants; fungi are the most suitable for the purpose, but the lichens (Figs. 434 and 636), the mosses (Figs. 332 and 414), and the algæ (Fig. 222), also the mycorrhiza of beech (Fig. 320), are particularly well defined. Discrimination between the photographs of flowering plants would be idle where nearly all are successful and convey their special meaning.

The eighth volume contains three extensive papers, a study by Dr. V. Gallemaerts of the phanerogams growing on willows, an investigation by Mrs. J. Schouteden-Wery as to the factors which regulate the distribution of algæ off the south-western region of the Belgian shore, and the observations of Dr. Vanderlinden mentioned above; in the last the observations, concerned chiefly with the comparative dates of flowering, extend over a period of fourteen years.

[1] "Recueil de l'Institut Botanique Léo Errera (Université de Bruxelles)." Publié par Jean Massart. Tome Supplémentaire vii.bis, pp. xii+332. Annexe au tome supplémentaire vii.bis, pp. iv+466 photographs+9 maps +2 diagrams+pp. v-xiii. Tome viii., pp. ix+383, avec Stéréoscope. (Bruxelles: Henri Lamerton, 1910 and 1911.)

BIOLOGICAL STUDIES IN JAVA.[1]

THE memoir referred to below contains a series of articles embodying the results of six months' study and observation in Java in the winter of 1909–10. The subjects dealt with are :—(1) climbing organs within the genus Randia; (2) Javan Myrmecodia; (3) the "silver-field" of *Haplochilus panchax*; (4) the microbiological processes in the humus of certain humus-collecting Epiphytes; (5) the bacteria nodules on the leaf-margins of *Ardisia crispa*.

Not the least interesting is the account of the author's investigation of the biological phenomena of *Myrmecodia tuberosa*, of *Hydnophytum montanum*, and, incidentally, of *Polypodium sinuosum*. Miehe briefly reviews the work of his predecessors, Beccari, Treub, and others, on the same subject, and adds a bibliography relating specially to the interrelations of ants and plants. The tuberous-stemmed rubiaceous genera Myrmecodia and Hydnophytum are among the most remarkable vegetable productions of the Malay Archipelago, alike in habit of growth and the economies of nutrition. These plants are epiphytes, usually gregarious, and commonly associated with the equally singular *Polypodium sinuosum*. They form irregularly shaped fleshy stems or tubers, ultimately 6 to 9 inches or more in diameter, with chambers and intersecting or blind galleries, in nature perhaps eventually always inhabited by a certain kind of ant and a fungus. A few short branches bearing a tuft of crowded leaves are given off from the tuberous stem, and the flowers are small and inconspicuous.

How far the association of these three organisms is an instance of beneficial symbiosis is still uncertain. Beccari, one of the earliest investigators and illustrators of this class of plants, came to the conclusion that the shape and development of the stems was entirely dependent on the action of the ants. But Treub proved by experiments with seedlings and older plants that the development of the thickened stems and the formation of galleries was absolutely independent of the ants. Hence some other use had to be sought for the passages and chambers open to exterior influences. Treub and subsequent investigators claim to have proved that these interior surfaces, which are of two kinds, play an important part in the economy of the plant, furnishing, in effect, the channels of absorption and transpiration. The absence of stomata from the exterior parts of the stem and tuber is advanced in support of this theory.

Miehe instituted further experiments to determine the nature of the vital functions of these two different surfaces of the galleries and chambers. In certain parts of the system the surface of the walls was smooth and of a "leather-yellow," in others black and warted. The result of numerous experiments was the same, namely, that the warty surface rapidly absorbs water, whereas the smooth surface does not possess this property. The fungus which inhabits the tubers has not been determined, but it is probably allied to Cladosporium and Cladotrichum.

[1] "Javanische Studien." By Hugo Miehe. Pp. 299–431. (Des xxxii. Bandes der Abhandlungen der Mathematisch-Physischen Klasse der Königlichen Sächsischen Gesellschaft der Wissenschaften, No. iv.) (Leipzig: B. G. Teubner, 1911.) Price 6 marks.

It is always present, and confined to those parts of the walls of the labyrinth which are studded with warts, there forming a dense carpet, which gives the dark colour to the walls. The ant, *Iridomyrmex myrmecodiae*, which inhabits the tubers under natural conditions is a small red one, but this was dispossessed by a larger black species in plants under cultivation in the garden of Buitenzorg.

The two kinds of wall-surface are thus briefly characterised:—"One part is smooth, light brown, impervious to water, free from fungus, and on which alone the ants place their pupæ; the other part is warty, discoloured, pervious to water, clothed with fungus, and never bears pupæ." Further, the ants deposit their excrement exclusively in the fungus galleries, so that the breeding part is kept pure and clean. Although a system of galleries and chambers is developed under artificial conditions independently of ants, the association of the three organisms points to a beneficial symbiosis whereby nutrition of the host plant is supplemented and the ants are provided with a home.

W. BOTTING HEMSLEY.

THE STUDY OF DAYLIGHT ILLUMINATION.[1]

PROF. L. WEBER has lately published an account of the series of tests of daylight illumination carried out by him in Kiel during the years 1905–8. Measurements of this kind were previously undertaken and described by the author so far back as 1890; his main object on this occasion has been to devise a more accurate and convenient means of specifying daylight illumination and the requisite window-area in interiors.

The results of a new and complete series of measurements of light from the unrestricted sky, carried out at mid-day, classified for the months of the year and extending over the years 1905–8, are now given. The author also describes an improved form of photometric apparatus specially devised for this work. The results of an extensive series of tests of the day-illumination in the State schools at Kiel are also presented. At the time of previous experiments the individual characteristics of the various class-rooms and the prevailing climatic conditions had not been sufficiently correlated, so that it was difficult to frame very precise general recommendations. Prof. H. Cohn has, however, suggested that the illumination on any desk should not fall below 25 metre-candles (approx. 2½ foot-candles), and that this result would in general be secured if the projected solid angle subtended by the window-area at this desk was not less than 50 square degrees.

This solid window-angle is often taken as the sole criterion of effective illumination. Yet it leaves out of account the effect of reflection from the walls in the room, and also the position of the window with respect to the surroundings outside.

An improvement now suggested by Prof. Weber takes the form of measuring the "light-value" (Lichtgüte) of the window. This quantity denotes the value of the projected area of the portion of the window-area which is entirely unobscured by surrounding trees or buildings, the area of the entire window being taken as 100. Prof. Weber describes two new instruments for the convenient measurement of these quantities.

Authorities, in estimating the daylight requirements of a room, usually require that the ratio of the window-area to the floor-area of the room should not exceed 1 : 6, or in some cases 1 : 10. The author suggests that if this ratio were multiplied by the "light-value" we should get a much more serviceable factor (which he denotes by P) for expressing the admission of light to the room.

Further data are needed before one can state quite definitely what value P should assume for various interiors, but this information could readily be obtained. As an illustration the author summarises the results of tests in 520 typical class-rooms, the illumination on the best and worst illuminated desks, and on a desk intermediate between these extreme positions, being studied. For 171 of the rooms P had a value >10, and in 304 rooms it was >5 but <10. In conclusion, he estimates that in only 5 per cent. of these class-rooms would the illumination, under average climatic conditions, during the year fall below Cohn's minimum of 25 metre-candles.

Prof. Weber next gives an account of his examination of the conditions of illumination in the library of the University of Kiel. He shows that, so far from complying with Cohn's minimum figure, even the best lighted tables would only receive 2–3 metre-candles during December. He also points out that the rule prescribing the window space for a given floor-area is quite inapplicable to rooms in which the floor is filled by vertical stacks of books, and that such shelves rarely receive sufficient light.

Finally, there is a communication from H. Borchardt which contains a summary of the theoretical and experimental methods employed for studying the distribution of brightness in the sky. A chart (based on a method devised by Prof. Weber) is given showing the approximate intensity and distribution at different periods of the year. The sky rarely approaches the ideal diffusely radiating hemisphere assumed in conventional calculations. The illumination is really due to mixture of diffused and transmitted light, the proportions of which vary with different climatic conditions. The distribution of brightness alters accordingly.

[1] A reprint from the *Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein*, Band xv., Heft i.

THE FLORA OF DAGHESTAN.

MR. N. I. KUZNETSOF concludes an article in the *Izvestiya* of the Imp. Russ. Geogr. Soc., Nos. 6–7, 1910, on the flora of the mountain region of Daghestan, with an historical sketch of its origin and distribution. Daghestan was raised above the water at the beginning of the Tertiary period, and its climate subsequently became drier and assumed a more continental character as the Sarmatic Sea around it dried up, and consequently the Tertiary forest which clothed it must have gradually dwindled. At the same time, the combined action of erosion and tectonic movements produced bare slopes, which, especially those facing south, afforded excellent conditions for the development of upland xerophytic vegetation. Here gathered forms which had existed in various parts of Daghestan from the beginning of the Tertiary period, and were now distributed, some in the north, others in the south, some on the schists, others on the limestones, and in connection with climatic conditions.

In the Glacial period Daghestan received fresh accessions from the north, and from the west through Asia Minor. Firs and birches now clothed the country, crowding out what was left of the Tertiary timber trees, which are now represented only by an occasional Tertiary birch, *Betula Raddeana*, or oak, *Quercus macranthera*. Many slopes, especially the southern, were never forested, and many limestone plateaus would not harbour arboreal vegetation, and there xerophytic types spread vigorously.

In the steppe period the forest trees retired into the heart of the country, their place being taken by xerophytic forms, while in the open valleys appeared representatives of the hot desert flora of the Mediterranean. The mountain xerophytic forms of Daghestan spread widely during this period. Some forms, not adapted to migration, remained in the country, others spread to other parts of the Caucasus, while those easily distributed extended so far as the steppes of South Russia, when these were laid bare by the retreat of the Pontic Sea. Maps accompanying the article show the distribution of the most characteristic forms.

VITAL EFFECTS OF RADIUM AND OTHER RAYS.[1]

ADOPTING the chronological order in which the radiations of radium and other sources were discovered and applied, the lecturer considered, in the first place, the effects of light and radiant heat, dwelling especially upon the fact that the chemical rays—*i.e.* blue, violet, and ultra-violet—were those which had vital effects upon the tissues. The differential effect of these rays as compared with those of longer wave-length at the other end of the

[1] Abstract of a discourse delivered at the Royal Institution, on February 2, by Sir James Mackenzie Davidson.

spectrum was well brought out in the course of an experiment in which, the spectrum having been produced upon the screen, a strip of bromide paper was stretched across it so as to receive the length of the spectrum, and this on being developed and fixed was shown to have darkened very considerably at the blue and violent portion, while the red end of the spectrum was practically white paper. The more ready absorption of these blue and violet rays, known to everyone who has looked at the reddened disc of the sun through a somewhat dense fog, was further illustrated by placing a glass cell in front of the lantern and filling it with hypo solution to which some hydrochloric acid was added. Ultimately, only the red waves were able to penetrate. The lecturer further pointed out that the blue colour was the last to be seen at the close of day; that when a person had his sight temporarily impaired by over-indulgence in tobacco he lost the perception of red and green in the centre of his field of vision, but very rarely lost the perception of blue; and that in cases of blindness coming on gradually from wasting of the optic nerve, blue was the last colour to go.

After reviewing the Finsen light treatment, which was based upon the fact that the most effective rays, physiologically speaking, were those of the violet and ultra-violet, and the superseding of the arc by a quartz mercury vapour lamp for the production of active violet light in large quantities, the lecturer turned to the X-rays, and spoke of the early X-ray burns sustained by operators, paying a tribute to Dr. Blacker, of St. Thomas's Hospital, one of the first martyrs in radiology. Sir James proceeded :—

"It is worthy of note that most, if not all, X-ray burns produced in operators began in the uncovered parts of their skin, such as the hands and face. A good deal of doubt still exists as to whether the primary X-rays alone are responsible for these manifestations. Having suffered from chronic X-ray burns in my hands, especially my right hand, it seemed to me rather remarkable that the area of trouble at the back of the hand should end sharply at a line corresponding to the usual position of the coat-cuff, for cloth, of course, is quite transparent to the X-rays, and the adjacent parts of the skin beneath the sleeve were in my own case equally exposed with the uncovered hand itself.

"Many views have been put forward to explain the causation of certain of the X-ray burns, but it appears probable that the secondary or indirect rays given off from the surface of the glass may be, if not in some cases the primary factors, certainly largely contributory to these superficial skin burns. As a further confirmation of the possibly vital effect of these rays upon the skin, I may mention that Freund, of Vienna, found that a tube so high as to give no fluorescence on the screen caused the hair to fall out, and also that, with a tube having the electric current passed in the reverse direction so as to produce only very weak primary X-rays, similar results were obtained. It would be interesting to construct a tube so as to employ for therapeutic purposes these secondary rays alone."

The lecturer demonstrated the existence of these secondary and less penetrating rays by exciting a Crookes tube in the ordinary way, and suspending opposite the point from which the primary rays emerge a mass of lead through which no primary or direct X-rays could possibly penetrate. Naturally, a shadow of the lead was cast by the X-rays coming from a fine point in the anode—the X-rays which may, for the present, be called the primary rays—but within this eclipsed area he obtained shadows caused by other rays, and when these were traced they were shown to be produced on the glass of the tube, which fluoresced green. These rays, he found, were more richly produced in what was called a "high" or "hard" tube. On making comparative measurements of the rays by means of the electroscope, he found that with a high tube giving very penetrative rays, if the action of the primary rays were taken as 1, the action of the secondary rays would be ½, and that with a low tube giving X-rays of a low order of penetrability, if the primary rays were again taken as 1, the secondary rays would be one-seventh.

The work done upon these secondary rays from the physical side is comparatively slight. Mr. Campbell Swinton alludes to their existence in a paper published in 1898, when he describes them as secondary rays from the green fluorescing glass of the X-ray tube; and at a somewhat earlier date Prof. Silvanus Thompson showed that the kathode stream, after impinging upon the target and thus giving rise to the main beam of X-rays, was reflected and impinged upon the glass walls of the tube, thus causing a green fluorescence. He called these reflected kathode rays "para-kathodic." "Whether they produce X-rays upon this second impact or not does not appear to have been proved," said Sir James Davidson in concluding this portion of his lecture, "but as Barkla and Sadler and others have demonstrated that X-rays outside the tube, impinging upon solid matter, give rise to secondary rays, it seems certain that the X-rays, in passing through the walls of the tube in which they are generated, must give rise to secondary X-rays, and it may well be the case that the green fluorescence of the glass of an X-ray tube gives us two sets of X-rays—one produced by the primary X-rays in their impact on passing through it, and the other produced possibly by reflected kathodal rays. Be that as it may—and it is a matter for the physicist—I feel sure that their physiological action upon the skin must be considerable, especially as they are much more readily absorbed than the primary X-rays."

Discussing the methods of protection against X-ray burns, the lecturer said that many years ago he made an experiment in which a Crookes tube was completely buried in a large quantity of red lead contained in a box, and when this was excited in a dark-room the fluorescent screen showed that no X-rays at all were able to penetrate. Then a small opening was made by scooping away the red lead until the primary rays got through, together with only a very few of the secondary rays from the small area of glass opposite the orifice. This was the most effective means of screening everybody from the rays except the individual under observation, but it was highly inconvenient, the apparatus being difficult to handle, especially when a fresh tube had to be embedded. Therefore a box was constructed, lined with a mixture of red and white lead, and a small hole was cut in it for the emission of the rays. Some such method, he added, was now generally adopted, and was most important for the protection of the workers. The lining of the fluorescent screen with thick lead-glass, and the Sabouraud pastille method of dosage, with other safeguards, rendered the X-rays, as applied for medical purposes, practically free from risk to operator and patient alike.

The lecturer then proceeded to describe the effects of X-rays upon cell-life, pointing out their radical influence upon the young and growing tissues. On the principle of attacking the young and growing cells, the X-rays injured the hair follicles and brought about the fall of the hair. The sweat glands could be destroyed in the same manner. The action of the X-rays upon the blood was limited chiefly to the white blood corpuscles, the red blood corpuscles being very resistant. The central nervous system also, fortunately, had great resisting capacity. The most sensitive of all the tissues were the lymphoid tissues generally, especially the spleen, which shrank and became strongly pigmented under the attack of the radiation. Indeed, in certain diseased conditions of the spleen the X-rays had been used with marked success. In malignant tumours, while the X-ray method might be of service in checking the rapidity of the growth, it could not be looked upon as a method of cure, although after the removal of such growths by operation the application of the rays to the involved area might assist in destroying any of the malignant cells which the surgeon's knife had missed, and thus preventing redevelopment. As the technique of the X-rays improved, the field of their utility in therapeutics would be gradually extended.

Next in order to the X-rays, historically, came radium. The events which led up to the discovery of this substance were summarised, and the physical properties of radium were described. The process of the disintegration of the radium atom, through which was evolved the radiant energy of such service in medicine, was admirably illus

trated by the very simple experiment of burning some magnesium sparking compound. In this process of flying to pieces the radium atom first gave off an atom of helium which was called the α ray, and the remainder of the atom evolved as a gas or emanation. The emanation in its turn decomposed, losing half its energy in about four days, and finally gave rise to an active deposit of rapid change, which gave off α, β, and γ rays. The action of the α rays on living cells was uncertain, but from some experiments which the lecturer had carried out with the "active deposit" from thorium he thought that the action of these rays upon the skin must be very slight.

The biological effects of radium had been closely studied upon a large variety of organisms. In the case of plants, for instance, a tube of radium placed upon a leaf would cause the irradiated area to lose its chlorophyll and to assume autumn tints. A prolonged exposure retarded the growth of seeds. Anthrax microbes had been found not to develop at all if left for twenty-four hours in an atmosphere charged with radium emanations. In Metchnikoff's laboratory at the Pasteur Institute, recently, it had been proved that certain toxins tended to lose their virulence after being made radiferous. When diphtheritic toxin was left for thirty days in contact with minute quantities of radium sulphate, the poisonous effect of the toxin was found to be much less rapid than in the case of the same toxin which had not been treated in this fashion. Young animals were particularly sensitive, especially in the epithelial tissues, and when animals had been killed by exposure to radium it was worthy of remark that paralysis and death were found to be due to internal hæmorrhages. The nerve cells had not shown any appreciable alteration. The central nervous system in all cases, indeed, was very resistant to radium action, but it suffered indirectly from the effects upon the vascular tissues.

"The date of my own first application of radium to the treatment of disease," continued the lecturer, "was May, 1903. The case was a large rodent ulcer, just below the right eye, which was rapidly progressing in spite of X-ray treatment. Two glass tubes, each containing 5 mg. of radium bromide, were applied tentatively for a short time to the upper border of this ulcer, and the application was cautiously repeated in the course of two or three days. The improvement was so manifest that the tubes were applied in the same manner over the general surface of the ulcer, which finally healed perfectly without scarring, and has remained well during the nine years that have since elapsed." While incapable of effecting a cure in certain severe and old-standing rodents, their progress was arrested in a marked manner, and considerable improvement of the condition was gained. "Radium has also proved to have a markedly specific action upon a troublesome disease of the eyelids known as 'spring catarrh.' This occurs in young people, the upper eyelids more particularly being covered with rough granulations. The disease was quite incurable until I applied radium to a little boy sent to me by Mr. Arnold Lawson, and with the use of radium every case treated has been completely and painlessly cured. A matter also worthy of remark is that from the commencement of the treatment, even before any appreciable improvement is visible, the patients express themselves as feeling the eyes much more comfortable, and they are able to use them in their ordinary occupations during the period of treatment.

"A further indication for radium therapy was discovered in the case of X-ray dermatitis. It was my misfortune to suffer from a chronic manifestation of this trouble, and three or four years ago a burnt patch on my hand became ulcerated. One portion was so threatening as to suggest malignancy, which is, unfortunately, a common result of these lesions. As nothing that was tried would effect a cure, it became a question of excision; but before resorting to this I applied radium in glass tubes, and was agreeably surprised to find that it completely cured the condition. The tube contained 20 mg. of pure radium bromide, and was left in position for twenty-five minutes. Nothing happened for twelve days, and then there occurred a certain amount of swelling and redness, the size of the black crust increased, and serum exuded from the side. This gradually subsided, and when the crust peeled off the normal healthy thin skin was found to be beneath it." Some striking photographs illustrated successively the dermatitis, the radium tube in position, the reaction, and the disappearance of the spot.

The lecturer went on to describe the apparatus for spreading radium, for enclosing it in tubes of metal and embedding it in the tumour, and for its metallic filtration so as to obtain a desired penetrability of ray. Some diseases yielded to radium more readily than others. Lupus was very resistant, but a great many other skin diseases, as well as *small* cancers of the tongue and lip, could be cured, while large, rapidly growing tumours like sarcoma could be cured by the method of burying tubes within them. Here, again, the fact was illustrated that these rays seemed to concentrate their attack upon young and most rapidly growing cells. That was probably the reason why sarcomas were so vulnerable to attack when compared with carcinomas, which were of slower growth. But in spite of its greater potency and convenience in application, the same thing had to be said of radium as was said of the X-rays—that it could not in any sense be looked upon as a cure for cancerous growths of large size. It would inhibit the further growth of such tumours, and even destroy them locally, but rarely completely, and it did nothing to prevent the usual secondary deposits. In the diseases for which the rays possessed curative properties, their action was extraordinarily selective, so that, if the dosage were well timed, they would destroy the abnormal cells without destroying the normal.

The effect of the emanation of radium, which when dissolved could be injected into the tissues, or, like the salt, could be confined in a metal tube and buried, was practically the same as with radium itself. The emanation gave 75 per cent. of the energy which would be obtained if the radium from which it came were embedded in its stead. When introduced into the system by inhalation, by injection, or by swallowing, the emanation seemed to have a capacity for stimulating the body ferments. He produced a standard for the radium emanation which had been given to him by Sir William Ramsay. It was in the form of a bottle containing 1/40,000th part of a milligram of pure radium.

In conclusion, the lecturer turned to the possibility of other radio-active substances, less forbidding in price and more readily available, taking the place of radium. Uranium, thorium, and actinium were radio-active, and had all been suggested in this connection, but they were too feeble to have any real efficacy. The discovery by Otto Hahn of a substance known as meso-thorium, which was one of the disintegration products of thorium, and was found in the course of an attempt to separate radio-thorium directly from thorium, had aroused considerable expectation. Meso-thorium emitted the same rays as radium, and, weight for weight, was more powerful. As the supply of thorium was much larger than that of pitchblende, from which radium was obtained, they might hope to have a larger supply of meso-thorium. It would cost much less, but, on the other hand, it had a short life of only about seven years. It was being experimented with medically in Germany. The lecturer had applied a tube, which he showed, equivalent to 10 mg. of pure radium, to a chronic patch of X-ray dermatitis on his hand, and a reaction followed fifteen days after application. The result promised to be favourable.

Radio-thorium gave off thorium emanation richly. This was a heavy gas, lasting seventy-six seconds, giving off α rays in profusion—rays which, impinging upon a sulphide of zinc screen, caused it to glow or fluoresce, a remarkable "spinthariscope" effect being observed when the screen was viewed with a magnifying glass. Thorium emanation also resembled that of radium in giving rise to an "active deposit," this becoming concentrated on the negative pole in an electric field. A metallic surface could in this way be made intensely radio-active, giving forth the α, β, and γ rays. The "active deposit" from the thorium emanation lasted for several hours. The lecture concluded with a very pretty demonstration of the thorium emanation passing through long tubes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Plans are before the University for doubling the size of the present School of Agriculture, the increase being rendered necessary in order to cope with the large accession of work entailed by the proposed assignment to the Cambridge School of Agriculture of grants from the Development Commissioners for research in plant-breeding and animal nutrition. It is suggested that the new building should extend from the western end of the present school towards Tennis Court Road.

The Site Syndicate has recommended that a site on the south-east corner of the Downing College site should be assigned for the erection of a building for the Forestry Department. The area measures 110 ft. by 36 ft.

Dr. Graham-Smith has been appointed university lecturer in hygiene until September 30, 1916.

Dr. J. Ward, professor of mental philosophy and logic, has been appointed chairman of the examiners for the Moral Sciences Tripos, 1912.

SIR DAVID GILL, K.C.B., F.R.S., will present prizes and certificates to students of the South-Western Polytechnic Institute, Chelsea, on March 15, at 8 p.m. Laboratories and workshops will be open afterward to public inspection.

IT is announced in the issue of *Science* for February 9 that conditional gifts of 20,000*l.* to Washington and Jefferson College at Washington, Pa., toward a 100,000*l.* fund, and 10,000*l.* to the Emory and Henry College at Emory, Va., toward a 50,000*l.* fund, were voted at a meeting of the General Education Board of the Rockefeller Foundation last January.

MR. J. C. MAXWELL GARNETT, a son of Dr. William Garnett, educational adviser to the London County Council, has been appointed to succeed Mr. J. H. Reynolds in the principalship of the Manchester Municipal School of Technology. Mr. Garnett had a brilliant career at school and Cambridge, where he was a wrangler in 1902, in the first division of the first class of Part ii. of the Mathematical Tripos in 1903, and a Smith's prizeman in 1904. He was for some time connected with the technological branch of the Board of Education, but was later made junior examiner in the elementary branch. His interests are, however, on the technical and scientific side, and he should find Manchester a congenial sphere for the exertion of his activities.

THE report of the executive committee of the Carnegie Trust for the Universities of Scotland, presented at the annual meeting of the Trust held on February 22, points out that the past year completed the first decade of the history of the Trust. The total income for the period amounted to 1,062,931*l.*, out of which 63,546*l.* was expended on research, 368,288*l.* in grants to universities and colleges, 445,373*l.* in payments of class fees for 11,480 individual students, and 30,158*l.* in administration. The income last year amounted to 108,542*l.*, and the gross expenditure to 83,160*l.*, including 7833*l.* for endowment of research, 21,182*l.* for grants to universities and colleges, 50,525*l.* for payments to students, and 3620*l.* for administration. During the year the sum of 339*l.* was voluntarily refunded on behalf of fourteen beneficiaries for whom class fees had been paid by the Trust.

GIFTS amounting to 16,260*l.* have been announced, says *Science*, by the trustees of Columbia University, including 6000*l.* from Dr. William H. Nichols for instruction and research laboratories in chemistry, and 5000*l.* from Mrs. Russell Sage for the E. G. Janeway Library endowment fund at the medical school. From the same source we learn that Transylvania University has announced that the effort to raise a fund of 50,000*l.* has been completed successfully. The largest gifts, apart from 10,000*l.* offered by the General Education Board in May, 1910, were as follows:—6000*l.* from Mr. R. A. Long, of Kansas City; three gifts of 5000*l.* each from Messrs. W. P. Bowers, of Muncie, Ind., Geo. H. Waters, of Pomona, Calif., and J. J. Atkins, of Elkton, Ky. Our contemporary also states that the completion of the 100,000*l.* endowment fund for Oberlin College has made possible the following additions to the college resources:—the men's building, 30,000*l.*; a new administration building, 10,000*l.*; the completion of the men's gymnasium, 10,000*l.*; for higher salaries, 40,000*l.*; and other endowments, 12,000*l.*

WE regret to learn that the position of Hartley University College, Southampton, at the present time is extremely critical, and unless a further sum of 10,000*l.* is raised by April 1 it is to be feared that the college will lose its status as a university college for Hampshire, Wiltshire, Dorsetshire, and the Isle of Wight. This will mean a very serious setback to education in the south of England, especially in view of the rapid growth of secondary schools throughout the area, all of which look to Southampton as their university. Inspectors appointed by the Advisory Committee of the Treasury visited Southampton in 1909, and although their report was entirely satisfactory as regards the work and development of the college, and its educational value to the area which it is intended to serve, yet the buildings were condemned as inadequate, and attention was directed to the lack of voluntary local support. On these grounds it was proposed that the annual grant of 2250*l.* should be reduced to 1500*l.* for the year ending March 31, 1911, after which date the grant should be entirely discontinued. Eventually, however, as the result of representations made by the college, the full grant was paid, and was renewed for the year ending March 31, 1912, on the understanding that about 31,000*l.* should be raised by that date, to be apportioned approximately as follows:—(*a*) 5000*l.* for the purchase of the new college site; (*b*) 21,000*l.* for the erection of two blocks, to accommodate the arts department (including the day training department); (*c*) 5000*l.* to form the nucleus of an endowment fund. Strenuous efforts have been made to raise this sum, sixteen committees being formed in various districts, with the result that 15,962*l.* has been given or promised, while the college can dispose of property in Southampton estimated at 5000*l.*, making a total of 20,962*l.* An excellent site has been procured, and satisfactory plans for the new buildings obtained in open competition. The amount available is therefore about 10,000*l.* short of the sum required to be raised by April 1, and if this sum is not forthcoming the college must collapse. It has been the experience of almost all university colleges that once the early difficulties have been mastered the growth of the institution is rapid and its success assured. There is every reason to believe that the result will be the same at Southampton if the additional sum of 10,000*l.* can be secured within the limited time allowed. Donations will be gratefully received by Mr. D. Kiddle, The Registrar, Hartley University College, Southampton.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, February 7.—Prof. W. W. Watts, F.R.S., president, in the chair.—Dr. A. H. **Cox**: An inlier of Longmyndian and Cambrian at Pedwardine (Herefordshire). The inlier comprises a strip of country about a mile in length and half a mile in breadth, situated near the border of Herefordshire and Radnorshire, about fifteen miles south of Church Stretton. Wenlock and Ludlow beds occupy most of the area around Pedwardine, but the occurrence of Cambrian Shale yielding Dictyonema has long been known. The Dictyonema Shales dip steeply westwards towards a series of red and green conglomerates and grits, with which an occasional thin shale-band is interbedded. The latter beds, previously mapped as Llandovery, are here referred to the Longmyndian. They also dip westwards, and have suffered disturbance, accompanied by overthrusting from the west. They are unfossiliferous, and neither on lithological nor on structural grounds can they be regarded as Llandovery strata resting unconformably upon the Cambrian. The grits at Pedwardine have apparently been carried south-eastwards over the Cambrian along an almost horizontal thrust-plane. There is also present a remnant of Bala grits, which dip gently eastwards, and rest with strong unconformity upon the Cambrian shales. The undisturbed character of these Bala beds suggests that the neighbouring thrust may be

of pre-Bala date. Later faulting along a north-and-south line has brought the members of these older formations against Wenlock and Ludlow beds. From the disturbed character of the Silurian strata to the west of the inlier it would appear that this inlier is part of a barrier which has preserved the district lying to the east from the effects of the post-Silurian movements.

Linnean Society, February 15.—Dr. D. H. Scott, F.R.S., president, in the chair.—R. H. **Compton**: An investigation of the seedling structure in the Leguminosæ. The tree habit is held to be primitive in the Leguminosæ, the herbaceous habit derived; these characters are correlated, respectively, with the production of large and small seeds, and therefore of large and small seedlings. A stable type of tetrarchy is correlated with large size of seedling, and is therefore probably primitive. Since both the type of symmetry and the level of transition are clearly related to the size of the seedling, it appears that, with certain possible exceptions, these anatomical features are not likely to be of more value in solving phytogenetic problems than the size-characters themselves.

Royal Anthropological Institute, February 20.—Dr. W. L. H. **Duckworth**: Cave exploration at Gibraltar during September, 1911. The excavations commenced by Dr. Duckworth in September, 1910 (*v.* NATURE, March 16, 1911, p. 100, and *The Athenæum*, March 11, 1911), were resumed in September, 1911. In the first instance, a fissure near "Beefsteak Cave," Europa Flats, was explored. It yielded stalagmite-encrusted bones of a stag, together with comparatively recent bones of domestic animals, as well as those of seabirds and hawks. A cave on the Mediterranean aspect of the Rock was entered. This cave is marked "4*a*" in the illustration of Genista Cave, No. 4 in Dr. Busk's paper. Cave 4*a* yielded many bones, representing a long list of mammals and birds, but no human remains came to light. Attention was then directed to Sewell's Cave (cave S) on the Mediterranean side, which yielded so many bones in 1910. Sewell's Cave was not completely explored in that year, but has now been thoroughly investigated. The most interesting finds in 1911 are several very delicate flint implements, a human tooth and wrist bone, part of a shell armlet, fitting on to a corresponding fragment found in 1910, a specimen of the mollusc *Nassa reticulata*, and a bone which is almost certainly that of a leopard. Fragments of pottery were also collected. Holyboy's Cave was again visited (*cf.* Report, 1910), and the hip bone of a small bear was found there on the surface of the floor. Apart from work in the caves, the fissures opening near the galleries, and the talus near the King's Lines, were inspected, some cervine bones being found *in situ* in one fissure.—A. L. **Lewis**: Some prehistoric monuments in the departments Gard and Bouches du Rhone.

EDINBURGH.

Royal Society, January 22.—Dr. J. Burgess, vice-president, in the chair.—G. H. **Gulliver**: Note upon the structure of ternary alloys. During the second period of solidification of a ternary alloy the temperature is not constant, and some liquid is always present. The crystals of the two separating phases are, therefore, enabled to grow to an appreciable size, and instead of the fine structure of a eutectic they have the form, and nearly the size, of the crystals of the primary phase.—Dr. R. A. **Houstoun** and his associates continued their researches on the absorption of light by inorganic salts: No. v. (by Dr. **Houstoun**), copper and the alkali metals; and No. vi. (by A. R. **Brown**), the cobalt chloride colour change. The former paper gave the molecular extinction coefficient for aqueous solutions of thirteen salts in the ultra-violet, visible spectrum, and infra-red. The values for the infra-red were obtained with a thermopile, and those for the ultra-violet by a new photographic photometer. This, however, did not prove so successful as the photographic photometer used in previous work along with J. S. Anderson. Part of the apparatus was a mirror spectroscope of original design, with nickel mirrors and automatic focussing. In the experimental work described in the second paper, anhydrous cobalt chloride was dissolved in mixtures of alcohol and water, and twenty-three different solutions were prepared, the solvent varying from pure water to pure alcohol through well-graded intermediate mixtures. The optical measurements were made with a spectrophotometer throughout the whole visible spectrum. The results were discussed mathematically with the help of the law of mass action, and it appeared that in the red aqueous solution of cobalt chloride each molecule of salt was combined with about fifteen molecules of water. Quantitative work done with a solid cobalt hexahydrate bore out this view, the absorption spectrum of the latter being quite different from the spectrum of the solution.—W. J. **Crawford**: The elastic strength of flat plates. This was an elaborate experimental investigation on the elastic strength of clamped circular and rectangular plates subject to a definite hydrostatic pressure on the one side. The analytical theory for circular plates was verified, and the results for various forms of rectangular plate were compared with Grashof's formulæ, which are purely empirical and not in harmony with fundamental principles of the theory of elasticity. Grashof's formulæ for the maximum stress and deflection were fairly well satisfied, but the experimental strength as measured by the curvature did not agree very well with Grashof's expressions.—Dr. J. H. **Ashworth**: Observations on the structure and affinities of *Branchiomaldane vincenti*, Langerhans. This small Polychæte exhibits several points of resemblance to a young ecaudate Arenicola, but differs from the latter in the position of its gills and in its nephridia, of which there are only two pairs. The second nephridium of *B. vincenti* is elongate, and extends through three or four segments. Although Branchiomaldane presents some primitive characters, it affords evidence of having undergone considerable retrogression, no doubt correlated with its tubicolous habits.

CAMBRIDGE.

Philosophical Society, January 29.—Sir George Darwin, K.C.B., F.R.S., president, in the chair.—R. H. **Clarke**: Demonstration of a stereotaxic instrument for directing insulated or other needles to any desired point in an animal's brain by graduated movement in three planes.—E. **Hindle**: Observations on fowl pest. The author has shown that the offspring of *Argas persicus* infected with *Spirochaeta gallinarum* are also infected, producing spirochætosis in the fowls on which they feed. Moreover, the eggs laid by ticks reared in the laboratory, and which have always been fed on healthy fowls, are found to be infected. These observations show that once an Argas becomes infected, the infection is maintained not only in the first generation, but also in the second.—C. **Strickland**: Gregarines in fleas.—Major **Cornwall**: The relation between the lytic point of red corpuscles in hypotonic salt solutions and the tonicity of the serum expressed in terms of NaCl. The mean range of lysis of the red corpuscles was very nearly the same for all the species experimented with, the average of the eight being 0·144 per cent. NaCl. The majority of the red corpuscles of any particular species are lysed at or about a particular dilution of salt, and comparatively few are either much more or much less resistant than the majority. These variations probably depend on the strength of the envelopes of the corpuscles. There is no obvious relation between the resistance of the corpuscles of any species to hypotonic lysis and their resistance to lysis by normal serums of other species. No definite relation could be discovered between the resistances of the red corpuscles and the tonicities of the serums. The high tonicity of serum is probably apparent and not real, and is perhaps due to some protein.—C. **Warburton**: The genus Rhipicephalus. Attention was directed to the genus Rhipicephalus of the Ixodidæ as presenting quite unusual difficulties to the systematist. Of course, in any group forms are liable to occur concerning which it is difficult to decide whether they ought to be regarded as distinct species or merely local varieties, but the difficulty in subdividing the genus Rhipicephalus goes much beyond this. Two forms so distinct that—on the analogy of other genera of ticks—no one would hesitate to recognise them as different species, are found in two different localities, where each is fairly constant to its type, but presently a number of specimens are collected from a single animal in a third locality completely connecting the two; and this occurs over and over again. It is suggested that we have here a very striking case of species in the act of formation, before intermediate forms have had

'me to disappear. The genus is essentially African. Only 'o or three so-called "species" of Rhipicephalus occur ut of Africa, and their distribution is easily accounted for by the fact that they are dog parasites. The other principal Ixodid genera are well distributed all over the world. —Prof. **Nuttall**: The parasites of equine biliary fever. Prof. Nuttall described the two species of parasites, *Piroplasma caballi* and *Nuttallia equi*, which occur in equine biliary fever in Africa, Asia, southern Europe, and South America. It has hitherto been supposed that biliary fever is due to but one species of parasite, but studies carried on in conjunction with Mr. C. Strickland have demonstrated that two diseases, due to distinct parasites, have hitherto been confused under one name. Both parasites are very deadly in their effects; they are transmitted from horse to horse by ticks, and the blood of animals which have recovered from all symptoms of the diseases remains infective for years.

MANCHESTER.

Literary and Philosophical Society, February 6.—Prof. F. E. Weiss, president, in the chair.—William **Burton**: Note on the earliest industrial use of platinum. The author gave an account of the general history of the mineral, particularly its use for coating pottery, and he exhibited specimens of pottery illustrating the application of various metals.—Prof. E. **Rutherford**: The origin of the β rays from radio-active substances. He stated that from a study of radio-active transformations it has been found that each atom of matter, in disintegrating, emits one α particle expelled with a definite velocity, which is characteristic of the substance. In many transformations, β and γ rays are emitted, and from analogy it would be expected that one β particle should be emitted for the transformation of each atom. The experiments, however, of Baeyer, Hahn, and Miss Meitner, and of Danysz, have shown that the emission of β rays from the radio-active substances is, in most cases, a very complicated phenomenon. The complexity of the radiation is most simply shown by observing in a vacuum the deflection of a narrow pencil of β rays by a magnetic field. If the rays fall normally on a photographic plate, a number of sharply marked bands are observed, indicating that the rays are complex, and consist of a number of homogeneous sets of rays, each of which is characterised by a definite velocity. The remarkable complexity of the β radiation is well instanced by the experiments of Danysz, who found that the products of radium B and C together emitted at least twenty-seven sets of homogeneous rays. Some of these had a velocity exceedingly close to that of light. Notwithstanding this apparent complexity, general experiments have shown that the number of β particles emitted from radium B and C is about that to be expected if each atom in breaking up emits only one β particle. In order to explain this complexity of the β rays, it is necessary to suppose either that the atom breaks up in a number of distinct ways, each of which is characterised by the emission of rays of definite velocity, or that the energy of the β particle can be reduced by certain definite amounts in its escape from the radio-active atom. The latter view appears more probable and more in accordance with the facts observed. It was found from an analysis of the results given by Danysz that certain relations existed between the energies of the individual β particles composing some of the different sets of rays. The difference in the energies of the β particles from radium B and from radium C could be expressed by a relation of the form $pa+qb$, where a and b were definite constants and p and q had integral values 0, 1, 2, 3, &c. This result may be explained by supposing that the β particle initially is liberated within the atom endowed with a certain speed, but that in escaping from the atom it may pass through two or more regions in which the quantity of energy a or b is abstracted. The number of these units of energy abstracted will vary from atom to atom, each individual atom probably giving rise to only a few of the types of β rays observed. Evidence was given that the values a and b served as a measure of the energy of the γ rays emitted from radium, and were connected with the energy of the β particle required to excite the characteristic radiations in the atoms of radium B or C. Prof. Rutherford said that it is of great theoretical importance to examine with the greatest care the nature of the emission of β rays from all the known radio-active substances, for it promises to throw a great deal of light on the interior structure of the atom.

DUBLIN.

Royal Irish Academy, February 12.—Dr. R. F. Scharff, vice-president, in the chair.—Rev. W. J. **Ryan** and T. **Halliday**: Some new fossils from Bray Head, co. Wicklow. This paper records the discovery, by the authors, of new fossils at Bray Head, co. Wicklow, in the formation known as the Bray and Howth series. As the field-relations of these beds to the adjoining altered shales are obscure, different opinions have been held by geologists as to their stratigraphical position in the geological series, and owing to the absence from the formation of well-recognised type-fossils, it has hitherto been impossible to fix the age of the rocks with any degree of certainty. The importance of the recent discovery lies in the possibility that the new fossils may possess a zonal value such as may finally settle this interesting question. Mr. Cowper Reed, who examined some of the fossils, thinks they suggest the head-shield of a large trilobite like *Solenopleura howleyi* from the Cambrian of Conception Bay, Newfoundland. Other fossils found closely resemble Walcott's holothurians, *Eldonia ludwigi* and *Louisella pedunculata*, from the Middle Cambrian Burgess Shale (Stephen formation), British Columbia. The authors infer that it is highly probable that the green and purple slates of Bray Head in which these fossils have been found must be referred to the same horizon of the Middle Cambrian as the Burgess Shale of British Columbia.—R. A. P. **Rogers**: Some differential properties of the orthogonal trajectories of a congruence of curves. The family of curves defined by $ldx+mdy+ndz=0$ are envelopes of "normal curves," *i.e.* those having l, m, n for normal at each point of space. Dupin's theorem, Darboux's reciprocal theorem, &c., are special cases of two simple relations connecting "normal torsions." The effect of inversion on normal torsion. The indicatrices of torsion and of curvature, and the relation between them. Expression of the condition of integrability as a relation between normal torsions. The indicatrix of form. Expression of the Curl-vector and Divergence by torsion, curvature, and the magnitude and direction of the gradient of the original vector. Second type of generalisations of Dupin's theorem, &c., arising from double generalisation of lines of curvature (Voss's *Krümmungslinien* and *Hauptkrümmungslinien*).—S. B. **Kelleher**: Poisson's equation and the equations of equilibrium of an elastic solid when the surface displacements are given.

BOOKS RECEIVED.

Farmers of Forty Centuries, or Permanent Agriculture in China, Korea, and Japan. By Dr. F. H. King. Pp. ix+441. (Madison, Wis.: Mrs. F. H. King.) 2.50 dollars.

Elements of Physiological Psychology. By Profs. G. T. Ladd and R. S. Woodworth. New edition. Pp. xix+704. (New York: Charles Scribner's Sons.) 4 dollars net.

Kaiserliche Akademie der Wissenschaften. Atlas Typischer Spektren. By Profs. J. M. Eder and E. Valenta. Pp. xv+143+Plates i. to liii. (Wien: A. Hölder.)

Carnegie Institution of Washington. Year Book No. 10, 1911. Pp. xvi+296. (Washington: Carnegie Institution.)

The Methods of Petrographic-Microscopic Research. By F. E. Wright. Pp. 204+plates. (Washington: Carnegie Institution.)

Feeding Experiments with Isolated Food-substances. By T. B. Osborne, L. B. Mendel, and E. L. Ferry. Part ii. Pp. 55–138. (Washington: Carnegie Institution.)

The Absorption Spectra of Solutions of Comparatively Rare Salts. By H. C. Jones and W. W. Strong. Pp. viii+112+plates. (Washington: Carnegie Institution.)

A New Algebra. By S. Barnard and J. M. Child. Vol. ii., containing parts iv.–vi. With Answers. Pp. x+301–731. (London: Macmillan and Co., Ltd.) 4*s*.

An Introduction to British Clays, Shales, and Sands. By A. B. Searle. Pp. xi+451. (London: Charles Griffin and Co., Ltd.) 7*s*. 6*d*. net.

Distribution and Origin of Life in America. By Dr. R. F. Scharff. Pp. xvi+497. (London: Constable and Co., Ltd.) 10*s.* 6*d.* net.

Organic Chemistry. By Profs. W. H. Perkin, F.R.S., and F. S. Kipping, F.R.S. Parts i. and ii. complete. New edition. Pp. xi+664+xx. (London and Edinburgh: W. and R. Chambers, Ltd.) 7*s.* 6*d.*

Theoretische Mechanik. By Prof. R. Marcolongo. Translated by Prof. H. E. Timerding. Zweiter Band. Dynamik. Pp. vii+344. (Leipzig and Berlin: B. G. Teubner.) 10 marks.

Das Weltproblem. By J. Petzoldt. Zweite Auflage. Pp. xii+210. (Leipzig and Berlin: B. G. Teubner.) 3 marks.

Historical Papers on Modern Explosives. By G. W. MacDonald. Pp. x+192. (London: Whittaker and Co.) 7*s.* 6*d.* net.

Zur Kenntnis des negativen Druckes in Flüssigkeiten. By J. Meyer. Pp. iii+53. (Halle: W. Knapp.) 2.10 marks.

The Clarendon Geography. Vol. i. By F. D. Herbertson. Pp. viii+379. (Oxford: Clarendon Press.) 3*s.*

Evolution in the Past. By H. R. Knipe. Pp. xv+242. (London: Herbert and Daniel.) 12*s.* 6*d.* net.

The Ox and its Kindred. By R. Lydekker, F.R.S. Pp. xi+271. (London: Methuen and Co., Ltd.) 6*s.*

Formal Logic: a Scientific and Social Problem. By Dr. F. C. S. Schiller. Pp. xviii+423. (London: Macmillan and Co., Ltd.) 10*s.* net.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 29.

ROYAL SOCIETY, at 4.30.—The Bacterial Production of Acetylmethylcarbinol and 2.3. Butylene Glycol. II: Dr. A. Harden, F.R.S., and Dorothy Norris.—An Instrument for Measuring the Distance between the Centres of Rotation of the Two Eyes: H. S. Ryland and B. T. Lang.—The Locomotor Function of the Lantern in *Echinus*, with remarks on other Allied Lantern Activities: Dr. J. F. Gemmill.—The Relation of Wild Animals to Trypanosomiasis: Capt. A. D. Fraser, R.A.M.C., and Dr. H. L. Duke.—The Transmission of *Trypanosoma nanum* (Laveran): Dr. H. L. Duke.—The Development of a Leucocytozoon of Guinea-pigs: E. H. Ross.

FRIDAY, MARCH 1.

ROYAL INSTITUTION, at 9.—The Total Solar Eclipse in the South Pacific, April, 1911: Dr. W. J. S. Lockyer.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Design and Construction of Masonry Dams: H. J. F. Gourley.

GEOLOGISTS' ASSOCIATION, at 8.—The Natural History of Petroleum: A. Wade.

SATURDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—Molecular Physics: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 4.

SOCIETY OF ENGINEERS, at 7.30.—The Trolley Vehicle System of Railless Traction: H. C. Adams.

ARISTOTELIAN SOCIETY, at 8.—A Theory of Material Fallacies: H. S. Shelton.

AERONAUTICAL SOCIETY, at 8.30.—Military Airships: Lieut. C. M. Waterlow, R.E.

ROYAL SOCIETY OF ARTS, at 8.—The Loom and Spindle: Past, Present and Future: Luther Hooper.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Photographic Process: Dr. C. E. Kenneth Mees.—Notes on the Estimation of Glucose in Leather: J. Gordon Parker and J. R. Blockey.

TUESDAY, MARCH 5.

ROYAL INSTITUTION, at 3.—Optical Determination of Stress, and some Applications to Engineering Problems: Prof. E. G. Coker.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Tribes of the Central Province of Southern Nigeria: N. W. Thomas.

RÖNTGEN SOCIETY, at 8.15.—Physiological Action of an Alternating Magnetic Field: Prof. S. P. Thompson, F.R.S.—Demonstration of Radiometer: W. Hampson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—(1) Roller and Ball Bearings; (2) The Testing of Anti-friction Bearing Metals: Prof. J. Goodman.

ZOOLOGICAL SOCIETY, at 8.30.—The Classification, Morphology, and Evolution of the Echinoidea Holectypoida: Herbert L. Hawkins.—Blood-Parasites found in the Zoological Gardens during the Four Years 1908–1911: H. G. Plimmer, F.R.S.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904–1906. Report on some Larval and Young Stages of Prawns from Lake Tanganyika: Dr. G. O. Sars.—On the Structure of the Internal Ear, and the Relation of the Basi-cranial Nerves in *Dicynodon*, and on the Homology of the Mammalian Auditory Ossicles: Dr. R. Broom.

WEDNESDAY, MARCH 6.

SOCIETY OF PUBLIC ANALYSTS, at 8.—A Method of Estimating Calcium Carbonate in Soils: H. S. Shrewsbury.—Standards for Malt Vinegar: A. C. Chapman.—The Estimation of Ammonia in Carbonated Waters: G. D. Elsdon and N. Evers.—A Note on a New Preservative for Milk, Cream, etc.—G. A. Stokes.

ROYAL SOCIETY OF ARTS, at 8.—Some Modern Problems of Illumination: The Measurement and Comparison of Light Sources: T. Thorne Baker.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 7.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) On the Devitrification of Silica Glass; (2) The Volatility of Metals of the Platinum Group: Sir William Crookes, O.M., For. Sec. R.S.—An Optical Load-extension Indicator, together with some Diagrams obtained therewith: Prof. W. E. Dalby.—(1) The Velocity of the Secondary Cathode Particles ejected by the Characteristic Röntgen Rays; (2) The Transmission of Cathode Rays through Matter: R. Whiddington.—On the Voltage Effect in Selenium: E. E. Fournier d'Albe.

LINNEAN SOCIETY, at 8.—Internodes of Calamites: Prof. Percy Groom.—Coloured Drawings of Barbados Plants: Miss Ethel M. Phillips.—On *Psygmophyllum majus*, sp. n., from the Lower Carboniferous Rocks of Newfoundland, together with a Revision of the Genus and Remarks on its Affinities: E. A. Newell Arber.—Historic Doubts about *Vaunthompsonia*: Rev. T. R. R. Stebbing.—Living Specimens of Cactoid Euphorbias from South Africa: Dr. Otto Stapf.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Tariffs for Electrical Energy, with Particular Reference to Domestic Tariffs: W. W. Lackie.

FRIDAY, MARCH 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—The Distribution and Habits of Alcpia, a Subgenus of Clausilia: Rev. A. H. Cooke.—A Synopsis of the Recent and Tertiary Freshwater Mollusca of the Californian Province. Part I., Pelecypoda and Pulmonata: H. Hannibal.—Note on the Existence of Two Editions of Férussac's Tableaux Systématiques: Major M. Connolly. Note on *Pleurotoma bipartita*, Smith: E. A. Smith.

PHYSICAL SOCIETY, at 8.—Exhibition of a "Method of Making Capillary Filaments": H. S. Souttar.—The Intensity at Points near the Principal Focus of an Object Glass with Symmetrical Aberration: J. Walker.—The Equipment of the Spectroscopic Laboratory of the Imperial College of Science: Prof. A. Fowler, F.R.S.

SATURDAY, MARCH 9.

ROYAL INSTITUTION, at 3.—Molecular Physics: Sir J. J. Thomson, F.R.S.

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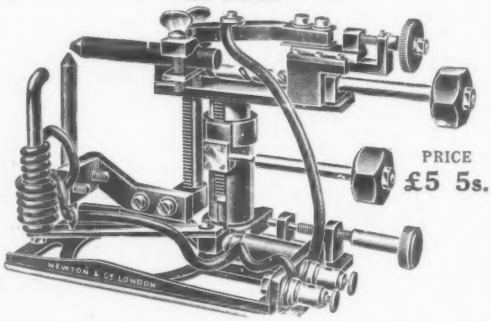

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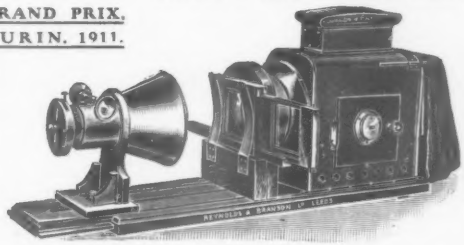

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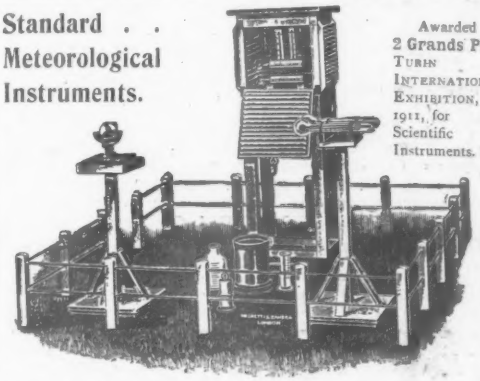

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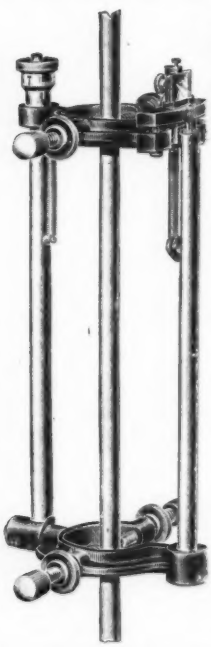

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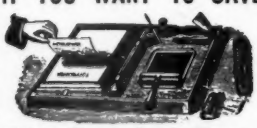

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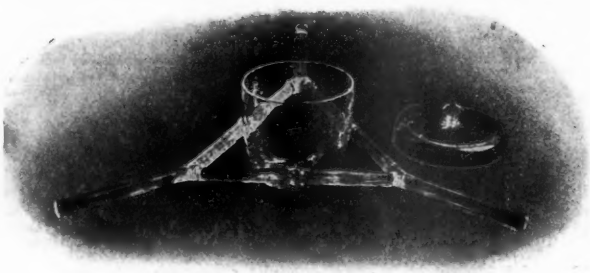

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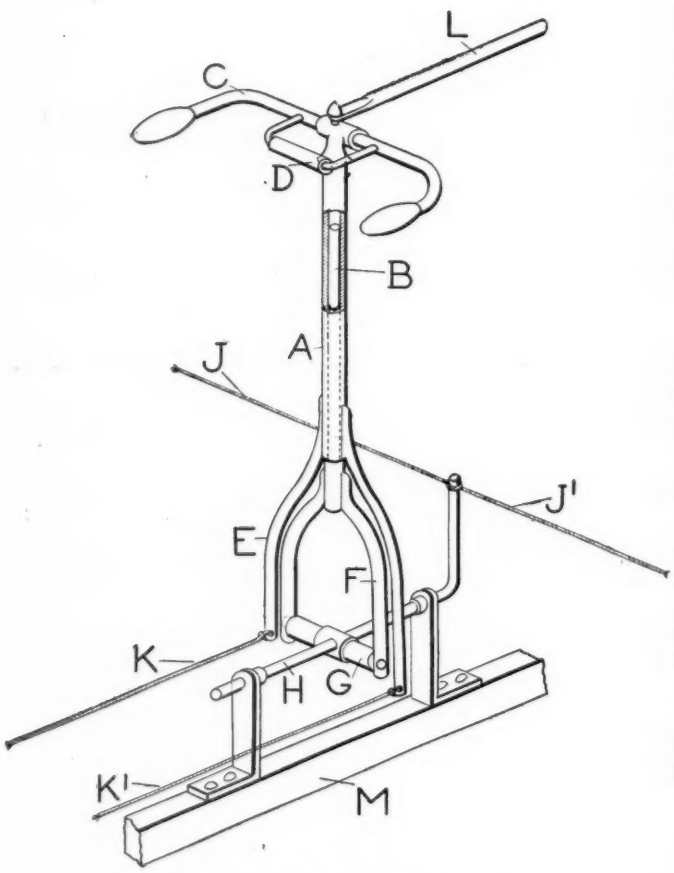

C, Handle bar, rigidly attached to tube **A** which has a rotary movement about rod **B.** **E,** Fork, rigidly attached to tube **A** and having connected, at its terminals, the cables **KK'** which actuate the vertical rudder. **F,** Fork, rigidly attached to rod **B** and having free rocking movement upon its terminal pivots. **H,** Rock-shaft actuated by **FG** and actuating the ailerons by the cables **JJ'.** **L,** Rod actuating elevator. **D,** Grip for single hand.

It will be seen in the diagram that the balancing motions of the aviator are natural, that is to say, in actuating the lateral and longitudinal rudders the movement of the handle-bars is in the direction which the swaying of the aviator's body would take if he sought to correct by his weight the rolling or pitching.

In examining the drawing it will be seen that there are three kinds of movement of the handle-bar:

(1) Both hands forward or aft.

(2) Both hands right or left, and also,

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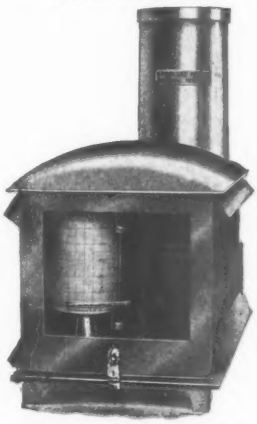

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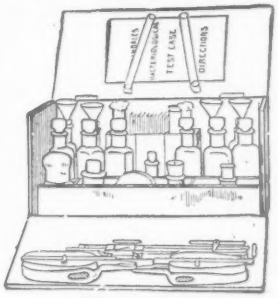

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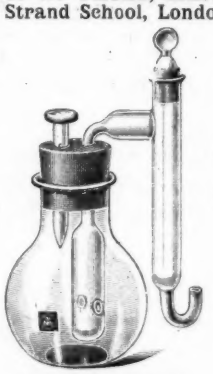

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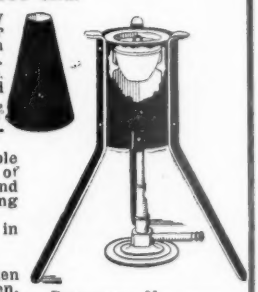

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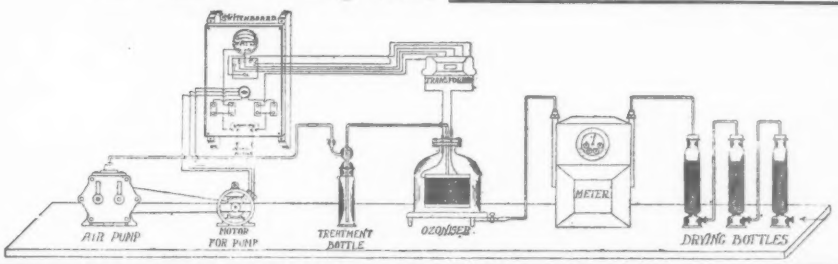

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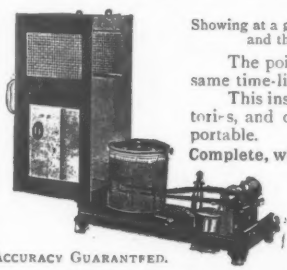

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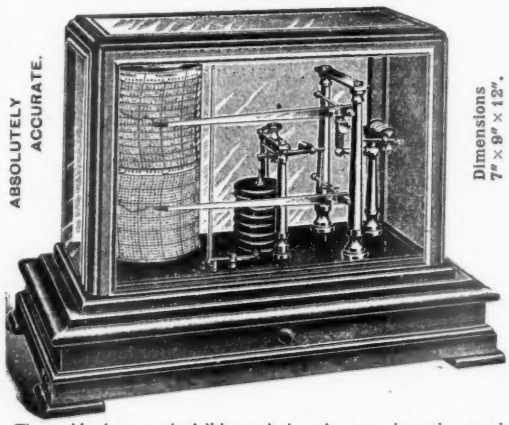

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